THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

Appellant(s):	Bernhard Raaf
Appl. No.:	10/009,858
Conf. No.:	6325
Filed:	December 22, 2001
Title:	METHOD OF CONTROLLING TRANSMISSION POWER IN A RADIO SYSTEM, AND A CORRESPONDING RADIO SYSTEM
Art Unit:	2617
Examiner:	Matthew C. Sams
Docket No.:	112740-344

Mail Stop
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

APPELLANTS' APPEAL BRIEF

Sir:

Appellants submit this Appeal Brief in support of the Notice of Appeal filed on September 20, 2007, along with the Pre-Appeal Brief Request for Review. This Appeal is taken from the Final Rejection in the Office Action dated July 20, 2007, Advisory Action dated August 20, 2007, and Notice of Panel Decision from Pre-Appeal Brief Review dated November 19, 2007.

I. REAL PARTY IN INTEREST

The real party in interest for the above-identified patent application on Appeal is Siemens Aktiengesellschaft ("Siemens AG") by virtue of an Assignment dated December 22, 2001 and recorded at reel 012554, frame 612 in the United States Patent and Trademark Office.

II. RELATED APPEALS AND INTERFERENCES

Appellants' legal representative and the Assignee of the above-identified patent application do not know of any prior or pending appeals, interferences or judicial proceedings which may be related to, directly affect or be directly affected by or have a bearing on the Board's decision with respect to the above-identified Appeal.

III. STATUS OF CLAIMS

Claims 25-32, 34-38, 40-43 and 45-48 are pending in the above-identified patent application. Claims 25-32, 34-38, 40-43 and 45-48 have been rejected. Accordingly, Claims 25-32, 34-38, 40-43 and 45-48 are being appealed in this Brief. A copy of the appealed claims is included in the Claims Appendix.

IV. STATUS OF AMENDMENTS

Claims 25, 34 and 37 were recently amended in the Response to Non-Final Rejection dated January 19, 2007. Claims 34, 25, 45 and 46 were previously amended in the Response to Non-Final Rejection dated July 6, 2006 to correct minor informalities. Claims 25 and 37 were amended in the Response dated January 19, 2006. Claim 25 was amended in the Response dated July 5, 2005 to correct a minor informality.

Appellants filed a Notice of Appeal in Response to the Final Office Action, as well as a Request for Pre-Appeal Brief Conference Request, on September 20, 2007. A copy of the Final Office Action, Advisory Action, and Notice of Panel Decision from Pre-Appeal Brief Review are respectively attached as Exhibits A-C in the Evidence Appendix.

V. SUMMARY OF CLAIMED SUBJECT MATTER

A summary of the invention by way of reference to the drawings and preliminarily amended specification for each of the independent claims is provided as follows:

Independent claims 25 and 37 recite a method and radio for controlling the transmission power in a radio system, where a signal received by a receiver is evaluated via a transmission channel of the radio system from a transmitter (page 2, lines 5-9, preliminary amendment 10/22/01). Power control information is produced as a function of the signal (page 2, lines 15-18), and embedded in a timeslot structure together with further data to be transmitted in the same timeslot to the transmitter (page 5, lines 12-22; page 7, lines 11-16). The receiver codes the power control information in one time slot (page 7, lines 11-16) in a manner where the power control information is coded, with the addition of redundancy (page 7, lines 17-23), together with the further data to be transmitted in the same time slot to form a common data word (page 7, line 27-page 8 line 2), with at least one bit value in the data word depending on the power control information and on the further data (page 8, lines 7-15). The coded power control information is transmitted in one timeslot to the transmitter, together with the further data to be transmitted in the same time slot, and the transmitter sets the transmission power as a function of the transmitted coded power control information (page 8, lines 16-27).

Although specification citations are given in accordance with C.F.R. 1.192(c), these reference numerals and citations are merely examples of where support may be found in the specification for the terms used in this section of the Brief. There is no intention to suggest in any way that the terms of the claims are limited to the examples in the specification. As demonstrated by the citations above, the claims are fully supported by the specification as required by law. However, it is improper under the law to read limitations from the specification into the claims. Pointing out specification support for the claim terminology as is done here to comply with rule 1.192(c) does not in any way limit the scope of the claims to those examples from which they find support. Nor does this exercise provide a mechanism for circumventing the law precluding reading limitations into the claims from the specification. In short, the specification citations are not to be construed as claim limitations or in any way used to limit the scope of the claims.

VI. GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

1. Claims 25-32, 34-38, 40-43 and 45-48 are rejected under 35 U.S.C. 103(a) as being unpatentable over *Uesugi et al.* (EP Patent 0893889) in view of *Hogan* (US Patent Pub. 2001/0018741).

VII. ARGUMENT

A. LEGAL STANDARDS

1. Obviousness under 35 U.S.C. §103

The Federal Circuit has held that the legal determination of an obviousness rejection under 35 U.S.C. § 103 is:

> whether the claimed invention as a whole would have been obvious to a person of ordinary skill in the art at the time the invention was made…The foundational facts for the prima facie case of obviousness are: (1) the scope and content of the prior art; (2) the difference between the prior art and the claimed invention; and (3) the level of ordinary skill in the art…Moreover, objective indicia such as commercial success and long felt need are relevant to the determination of obviousness…Thus, each obviousness determination rests on its own facts.

In re Mayne, 41 U.S.P.Q. 2d 1451, 1453 (Fed. Cir. 1997).

In making this determination, the Patent Office has the initial burden of proving a *prima facie* case of obviousness. *In re Rijckaert*, 9 F.3d 1531, 1532, 28 U.S.P.Q. 2d 1955, 1956 (Fed. Cir. 1993). This burden may only be overcome "by showing some objective teaching in the prior art or that knowledge generally available to one of ordinary skill in the art would lead that individual to combine the relevant teachings." *In re Fine*, 837 F.2d 1071, 1074, 5 U.S.P.Q. 2d 1596, 1598 (Fed. Cir. 1988). "If the examination at the initial stage does not produce a prima facie case of unpatentability, then without more the Appellant is entitled to grant of the patent." *In re Oetiker*, 24 U.S.P.Q. 2d 1443, 1444 (Fed. Cir. 1992).

Moreover, the Patent Office must provide explicit reasons why the claimed invention is obvious in view of the prior art. The Supreme Court has emphasized that when formulating a rejection under 35 U.S.C. § 103(a) based upon a combination of prior art elements it remains necessary to identify the reason why a person of ordinary skill in the art would have combined the prior art elements in the manner claimed. *KSR v. Teleflex*, 127 S. Ct. 1727 (2007).

Of course, references must be considered as a whole and those portions teaching against or away from the claimed invention must be considered. *Bausch & Lomb, Inc. v. Barnes-Hind/Hydrocurve Inc.* , 796 F.2d 443 (Fed. Cir. 1986). "A prior art reference may be considered to teach away when a person of ordinary skill, upon reading the reference would be discouraged

from following the path set out in the reference, or would be led in a direction divergent from the path that was taken by the Appellant." *Monarch Knitting Machinery Corp. v. Fukuhara Industrial Trading Co., Ltd.*, 139 F.3d 1009 (Fed. Cir. 1998), quoting, *In re Gurley*, 27 F.3d 551 (Fed. Cir. 1994).

B. THE CLAIMED INVENTION

Independent claim 25 is directed to a method for controlling the transmission power in a radio system. A signal received by a receiver is evaluated via a transmission channel of the radio system from a transmitter, and power control information is produced as a function of the signal. The power control information is embedded in a timeslot structure together with further data to be transmitted in the same timeslot to said transmitter. A receiver codes the power control information in one time slot in a manner where the power control information is coded, with the addition of redundancy, together with the further data to be transmitted in the same time slot to form a common data word, with at least one bit value in the data word depending on the power control information and on the further data. The coded power control information is then transmitted in one timeslot to the transmitter, together with the further data to be transmitted in the same time slot, and the transmitter sets the transmission power as a function of the transmitted coded power control information.

Independent claim 37 is directed to a radio system, comprising a transmitter and a receiver. The receiver receives a signal from the transmitter, which is transmitted via a transmission channel of the mobile radio system. The receiver (1) evaluates the signal, (2) produces power control information as a function of the signal, (3) embeds the power control information in a timeslot structure together with further data to be transmitted in the same timeslot to the transmitter, and (4) codes the power control information in a one time slot in a manner where the power control information is coded, with the addition of redundancy, together with the further data to be transmitted in the same time slot to form a common data word, with at least one bit value in the data word depending on the power control information and on the further data. The receiver then transmits the coded power control information in one timeslot to the transmitter, together with the further data to be transmitted in the same time slot. The

transmitter then sets the transmission power as a function of the transmitted coded power control information.

C. THE REJECTION OF CLAIMS 25-32, 34-38, 40-43 and 45-48 UNDER 35 U.S.C. §103(A) SHOULD REVERSED, BECAUSE *UESUGI* AND *HOGAN* FAIL TO TEACH EVERY ELEMENT RECITED IN THE CLAIMS

Specifically, the cited art, alone or in combination, fails to teach "embedding the power control information in a timeslot structure together with further data to be transmitted in the same timeslot to said transmitter; coding, in the receiver, the power control information in one time slot in a manner where the power control information is coded, with the addition of redundancy, together with the further data to be transmitted in the same time slot to form a common data word, with at least one bit value in the data word depending on the power control information and on the further data; transmitting the coded power control information in one timeslot to the transmitter, together with the further data to be transmitted in the same time slot; and setting, in the transmitter, the transmission power as a function of the transmitted coded power control information" as recited in claim 25 and similarly recited in claim 37.

Under the recited configuration, the power control information, transmitted in one timeslot, is coded together with further data which is intended to be transmitted in the same timeslot. Both the power control information and this further data or information are transmitted so that the power control information (e.g., TPC bits) transmitted in one timeslot is not simply transmitted repeatedly, but is coded together with further bits, which are intended to be transmitted within the same timeslot. The further bits may be, for example, the bits in the TFI information (TFI bits) in a mobile radio system. However, it is understood that other bits, for example data bits, also can be used for coding with the TPC bits, provided they are intended to be, or can be, transmitted in the same timeslot at the TPC bits.

In contrast, Uesugi discloses a method and an apparatus for adjusting the transmitting power in a CDMA communication system, where (1) a rate judging apparatus judges the rate of transmission data by a first slot of a transmission frame, (2) a level controller which carries out processing by which the transmission power of transmission control information given to the top of the respective slots after the second slot is made identical to that of the transmission data, and (3) a transmitter transmits frames processed by uniform transmission power responsive to the

result of the judgment (col. 3, lines 16-26). Under this arrangement, transmission frames are purportedly transmitted with uniform transmission power regardless of the transmission data rate (col. 4, lines 28-35).

In col. 19, lines 48-51 and FIG. 16B, Uesugi discloses a case where the transmission data rate is low, thus prompting the CDMA communication apparatus to *repeatedly transmit* transmission data along with the controlling information and transmission data (see also col. 6, lines 33-42). This is done according to Uesugi to account for transmission data (1200) that is spread-controlled by spread controller 1201. Thus, if the transmission data rate is low, the transmission data is processed so that it has a small amplitude and a long symbol length (hence the repeating), and if the transmission data rate is high, the transmission data is processed so that it has a large amplitude and a short symbol length.

The Final Office Action and Advisory Action alleges that col. 12, line 41 - col. 13, line 2 (FIGs. 16A-B) discloses the feature of "embedding the power control information in a timeslot structure together with further data to be transmitted in the same timeslot." Appellant respectfully submits this is incorrect. The Disclosure in Uesugi clearly shows that the time multiplexer 1203 multiplexes the pilot symbol 1202 and the power controlling signal (TPC) 1207, and the transmission data is CDMA-modulated by CDMA modulator 1204, amplified, and transmitted through antenna 1206 (col. 12, lines 35-47). It is apparent to the Appellant that the CDMA modulation of Uesugi does not represent the encoding process described in the present claims, where the receiver codes the power control information in one time slot in a manner where the power control information is coded, with the addition of redundancy, together with the further data to be transmitted in the same time slot to form a common data word, with at least one bit value in the data word depending on the power control information and on the further data.

Under the claimed configuration, a number of bits are encoded together (e.g., a number of output bits are formed dependent on the number of input bits wherein at least a part of the output bits are dependent on a number of input bits) (therefore not only on one). As a result of coding, a common data word (e.g., block code) is formed, where one bit value in the data word is dependent upon the power control information and on the further data Also, the claim provides for redundant encoding. The Uesugi reference is silent in this regard and instead teaches combined multiplexing of a spread code provided by the spread controller (1201). Uesugi

clearly states that multiple time slots are used for the different signals (see, e.g., col. 19, lines 1-4: [i]f the data rate is low, pilot symbol 4051, TPC signal 4052 or data symbol 4053 is transmitted by the same transmission power in slots including and after the second slot as shown in FIG. 14G"; see also col. 18, lines 1-6, 29-30, 38-39).

Also, no redundancy is disclosed in Uesugi, *with respect to the one time slot* - in col. 19, line 48 - col. 20, line 9, the reference clearly states that the *entire transmission data* is retransmitted regularly to establish a proper data rate. The Advisory Action states that "it is not clearly claimed what is redundant" (see page 2), and has apparently interpreted the repeated transmission of data as being equivalent to "redundancy" (col. 19, lines 46-52). However, such an interpretation has no relation to the present claims, where the redundancy is related to the encoding in the receiver. It is not understood by Appellant how this feature is taught in Uesugi simply by retransmitting data, based on the determined data rate. Uesugi states that "by the same transmission data being repeated, the receiving side is able to judge that the transmission data rate is low" (col. 19, line 57 - col. 20, line 1). This clearly shows that the receiver does not "encode" anything, merely receives the data and determines whether or not the data rate is low or high (see col. 3, lines 16-26; col. 20, lines 1-6).

Also, as the Office Action has conceded, Uesugi fails to teach or suggest "one bit value in the data word depending on the power control information and on the further data."

Regarding Hogan, the application discusses XOR logic, where error correction bits are added to a code word in an ECC block related to a data storage computer system (see Abstract). While ECC bits are dependent on the data word, the bits are taken from an encryption mask ([0027]) and appended to the codeword ([0036-37]). Aside from the isolated fact that ECC bits are related to the codeword through the XOR function, Hogan clearly bears no relation to power control and does not disclose that one bit value in the data word depends on the power control information and on the further data.

C. THE REJECTION OF CLAIMS 25-32, 34-38, 40-43 and 45-48 UNDER 35 U.S.C. §103(A) SHOULD REVERSED, BECAUSE THERE IS NO TEACHING, SUGGESTION OR MOTIVATION TO COMBINE *UESUGI* AND *HOGAN* IN THE MANNER SUGGESTED BY THE EXAMINER.

Contrary to the Office Action's assertion that Hogan is in an analogous art, Applicant respectfully submits that the two references are disparate. Hogan deals with encrypted "heroic data recovery" related to computer storage systems, where destroyed data may be recovered (see [0006]). As discussed above, Uesugi deals with adjusting the transmitting power in a CDMA communication system. Hogan also teaches that the ECC blocks are used in an encrypted manner to allow secure data recovery (see, e.g., claim 1). As discussed above, Uesugi relies on retransmission of data blocks to establish a proper data rate. Paradoxically, the Office Action asserts that incorporating Hogan into Uesugi would "reduce the need for retransmission of lost data," which runs expressly counter to the teaching in Uesugi, since retransmission is needed to be able to distinguish between different data rates (see col. 19, line 57 - col. 20, line 6). Appellant is at a loss understanding the manner in which an encrypted XOR function would conceivably operate in Uesugi - which bits are to be XORed? If the data is encrypted, how does Uesugi effectively deal with each re-transmission and related multiplexing? It appears to the Applicant that such a combination is not possible.

The Advisory Action further alleges that "Uesugi obviously already handles 'encrypted data'" (last paragraph), and provides an alleged example of an encryption scheme that is as "simple as representing a 1 as a 1 and a 0 as a 1 (i.e., coding for digital communication)." Applicant respectfully submits that the relevance of this passage is entirely unclear, and it is not understood what type of "encryption" this refers to. Even assuming that the example ("representing a 1 as a 1 and a 0 as a 1") represents some form of encryption, how would this "encryption scheme" be implemented in Uesugi? How would the decryption be implemented among the multiple devices? What bits would be subject to this encryption? In order to clarify these questions for the Board, Appellant kindly request that the Examiner's Answer address these issues prior to the decision.

For at least these reasons, Appellant submits the rejection under 35 U.S.C. §103 is improper and should be reversed.

VIII. CONCLUSION

Appellants respectfully submit that Claims 25-32, 34-38, 40-43 and 45-48 are non-obvious in view of the cited references for the reasons previously discussed. Accordingly, Appellants respectfully submit that the rejections under 35 U.S.C. §103(a) are erroneous in law and in fact and should therefore be reversed by this Board.

The Director is authorized to charge any additional fees which may be required, or to credit any overpayment to Deposit Account No. 02-1818. If such a withdrawal is made, please indicate the Attorney Docket No. 112740-344 on the account statement.

Respectfully submitted,

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Dated: December 19, 2007

CLAIMS APPENDIX

PENDING CLAIMS ON APPEAL OF U.S. PATENT APPLICATION SERIAL NO. 10/009,858

Claims 1-24. (canceled).

Claim 25. A method for controlling the transmission power in a radio system, the method comprising the steps of:

evaluating a signal received by a receiver via a transmission channel of the radio system from a transmitter;

producing power control information as a function of the signal;

embedding the power control information in a timeslot structure together with further data to be transmitted in the same timeslot to said transmitter

coding, in the receiver, the power control information in one time slot in a manner where the power control information is coded, with the addition of redundancy, together with the further data to be transmitted in the same time slot to form a common data word, with at least one bit value in the data word depending on the power control information and on the further data; and

transmitting the coded power control information in one timeslot to the transmitter, together with the further data to be transmitted in the same time slot; and

setting, in the transmitter, the transmission power as a function of the transmitted coded power control information

Claim 26. A method for controlling the transmission power in a radio system as claimed in Claim 25, wherein the further data is data for format identification information.

Claim 27. A method for controlling the transmission power in a radio system as claimed in Claim 25, wherein the further data is user data.

Claim 28. A method for controlling the transmission power in a radio system as claimed in Claim 25, wherein the power control information is transmitted in binary form.

Claim 29. A method for controlling the transmission power in a radio system as claimed in Claim 28, wherein bits in the power control information are coded with bits of the further data to form a common binary data word.

Claim 30. A method for controlling the transmission power in a radio system as claimed in Claim 29, wherein the coded data word comprises a plurality of bits corresponding to a sum of the bits in the power control information and the bits in the further data.

Claim 31. A method for controlling the transmission power in a radio system as claimed in Claim 29, wherein, during the coding process, at least one bit in the coded data word is assigned a value of the power control information to be transmitted in the corresponding time slot.

Claim 32. A method for controlling the transmission power in a radio system as claimed in Claim 29, wherein, during the coding process, at least one bit in the coded data word is assigned a value of the power control information to be transmitted in the corresponding time slot from the further data.

Claim 33. (canceled).

Claim 34. A method for controlling the transmission power in a radio system as claimed in Claim 25, wherein during the coding process, at least one bit in the coded data word is assigned a value which corresponds to a logic operation between the power control information to be transmitted in the corresponding time slot and the information to be transmitted in the same time slot from the further data, and a logic exclusive-OR operation is used as the logic operation.

Claim 35. A method for controlling the transmission power in a radio system as claimed in Claim 25, the method further comprising the step of:

recovering the power control information in the transmitter via appropriate decoding, with an estimated value being determined for the power control information during the decoding

process based on the value obtained by the logic operation from the corresponding bit in the coded data word.

Claim 36. A method for controlling the transmission power in a radio system as claimed in Claim 25, wherein the receiver which produces the coded power control information is a base station in a mobile radio system, and the transmitter which received the power control information and sets its transmission level appropriately is a mobile station in the mobile radio system, such that the coded power control information is transmitted via a downlink connection between the receiver and the transmitter.

Claim 37. A radio system, comprising:

a transmitter; and

a receiver for receiving a signal from the transmitter, which is transmitted via a transmission channel of the mobile radio system, wherein the receiver:

evaluates the signal;

produces power control information as a function of the signal;

embeds the power control information in a timeslot structure together with further data to be transmitted in the same timeslot to said transmitter;

codes the power control information in a one time slot in a manner where the power control information is coded, with the addition of redundancy, together with the further data to be transmitted in the same time slot to form a common data word, with at least one bit value in the data word depending on the power control information and on the further data; and

transmits the coded power control information in one timeslot to the transmitter, together with the further data to be transmitted in the same time slot,

and wherein the transmitter sets the transmission power as a function of the transmitted coded power control information

Claim 38. A radio system as claimed in Claim 37, wherein the receiver codes the power control information together with data from format identification information for the same time slot.

Claim 39. (canceled).

Claim 40. A radio system as claimed in Claim 37, wherein the receiver send the power control information to the transmitter in a binary form.

Claim 41. A radio system as claimed in Claim 40, wherein the receiver codes bits in the power control information together with bits in the further data to form a common binary data word.

Claim 42. (previously presented) A radio system as claimed in Claim 41, wherein the receiver, during the coding process, assigns at least one bit in the coded common data word a value of the power control information to be transmitted in the corresponding time slot.

Claim 43. A radio system as claimed in Claim 41, wherein the receiver, during the coding process, assigns at least one bit in the coded common data word a value of the power control information to be transmitted in the corresponding time slot from the further data.

Claim 44. (canceled).

Claim 45. A radio system as claimed in Claim 37, wherein the logic operation carried out by the receiver during the coding process is a logic exclusive-OR operation.

Claim 46. (previously presented) A radio system as claimed in Claim 37, wherein the transmitter, after receiving the coded common data word, recovers the power control information via appropriate decoding and determines an estimated value for the power control information based on the value obtained by the logic operation form the corresponding bit in the coded common data word.

Claim 47. A radio system as claimed in Claim 37, wherein the radio system is a CDMA mobile radio system.

Claim 48. A radio system as claimed in Claim 47, wherein the receiver which produces the coded binary power control information is a base station in the mobile radio system, and the transmitter which receives the power control information and sets its transmission power appropriately is a mobile station in the mobile radio system.

EVIDENCE APPENDIX

EXHIBIT A: Final Office Action dated April 20, 2007.

EXHIBIT B: Advisory Action dated August 20, 2007.

EXHIBIT C: Notice of Panel Decision from Pre-Appeal Brief Review, dated November 19, 2007.

EXHIBIT D: *Uesugi et al.* (EP 0893889), cited by the Examiner in the Final Office Action dated April 20, 2007.

EXHIBIT E: *Hogan* (US Patent Pub. 2001/0018741), cited by the Examiner in the Final Office Action dated April 20, 2007.

RELATED PROCEEDINGS APPENDIX

None

APPENDIX A

Final Office Action dated April 20, 2007.

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/009,858	12/22/2001	Bernhard Raaf	112740-344	6325

29177 7590 04/20/2007

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EXAMINER	
SAMS, MATTHEW C	
ART UNIT	PAPER NUMBER
2617	

Due: 7-20-07

SHORTENED STATUTORY PERIOD OF RESPONSE	MAIL DATE	DELIVERY MODE
3 MONTHS	04/20/2007	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

If NO period for reply is specified above, the maximum statutory period will apply and will expire 6 MONTHS from the mailing date of this communication.

F

Office Action Summary	Application No.	Applicant(s)	
	10/009,858	RAAF, BERNHARD	
	Examiner	Art Unit	
	Matthew C. Sams	2617	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE *3* MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *19 January 2007*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *25-32,34-38,40-43 and 45-48* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *25-32,34-38,40-43 and 45-48* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

Response to Amendment

1. This office action has been changed in response to the amendment filed on 1/19/2007.

Claim Rejections - 35 USC § 103

2. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

3. The factual inquiries set forth in *Graham* **v.** *John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

4. Claims 25-32, 34-43 and 45-48 are rejected under 35 U.S.C. 103(a) as being unpatentable over Uesugi et al. (EP 0 893,889 A2 hereinafter, Uesugi) in view of Hogan (US 2001/0018741).

Regarding claim 25, Uesugi teaches a method for controlling the transmission power in a radio system (Abstract) comprising:

evaluating a signal received by a receiver via a transmission channel of the radio system from a transmitter; (Col. 12 lines 21-26)

producing power control information as a function of the signal; (Col. 12 line 57 through Col. 13 line 2)

embedding the power control information in a timeslot structure together with further data to be transmitted in the same timeslot to said transmitter; (Col. 12 line 41 through Col. 13 line 2, Fig. 16A & Fig. 16B)

coding, in the receiver, the power control information in one time slot in a manner where the power control information is coded, with the addition of redundancy, together with further data to be transmitted in the same time slot to form a common data word; and (Col. 19 lines 48-51 and Fig. 16B)

transmitting the power control information in one timeslot to the transmitter, together with the further data to be transmitted in the same time slot; (Fig. 16B and Col. 19 lines 48-51) and

setting, in the transmitter, the transmission power as a function of the transmitted coded power control information. (Col. 12 line 41 through Col. 13 line 2)

Uesugi differs from the claimed invention by not explicitly reciting with at least one bit value in the data word depending on the power control information and on the further data.

In an analogous art, Hogan teaches a method and apparatus for performing encryption and error coding correction that includes the usage of an exclusive-OR logic operation (Page 1 [0012-0013] and Page 2 [0027]), wherein once the addition of error

correction bits are added to a code word containing power control information and further data, at least one bit value (error correction bit) in the data word is depending on the power control information and on the further data. At the time the invention was made, it would have been obvious to one of ordinary skill in the art to implement the method of power control of Uesugi after modifying it to incorporate the error coding correction of Hogan. One of ordinary skill in the art would have been motivated to do this since it enables a simple error correction that reduces the need for retransmission of lost data. (Page 1 [0003 & 0006])

Regarding claim 26, Uesugi in view of Hogan teaches the further data is data for format identification information. (Uesugi Fig. 5 pilot symbol "P")

Regarding claim 27, Uesugi in view of Hogan teaches the further data is user data. (Uesugi Col. 8 line 34-38)

Regarding claim 28, Uesugi in view of Hogan teaches the power control information is transmitted in binary form. (Uesugi Col. 1 line 9)

Regarding claim 29, Uesugi in view of Hogan teaches the bits in the power control word comprises a plurality of bits corresponding to a sum of the bits in the power control information and the bits in the further data. (Uesugi Fig. 16B and Col. 19 lines 48-51)

Regarding claim 30, Uesugi in view of Hogan teaches the coded data word comprises a plurality of bits corresponding to a sum of the bits in the power control information and the bits in the further data. (Uesugi Fig. 11 and Col. 16 lines 37-40)

Regarding claim 31, Uesugi in view of Hogan teaches that during the coding process, at least one bit in the coded data word is assigned a value of the power control information to be transmitted in the corresponding time slot. (Uesugi Fig. 5A [TPC] and Col. 19 lines 48-51)

Regarding claim 32, Uesugi in view of Hogan teaches that during the coding process, at least one bit in the coded data word is assigned a value of the power control information to be transmitted in the corresponding time slot from the further data. (Uesugi Col. 19 lines 48-51)

Regarding claim 34, Uesugi in view of Hogan teaches during the coding process, at least one bit in the coded data word is assigned a value which corresponds to a logic operation between the power control information to be transmitted in the corresponding time slot and the information to be transmitted in the same time slot from the further data, (Uesugi Fig. 16A, Fig. 16B and Col. 19 lines 48-51) and a logic exclusive-OR operation as the logic operation used in the coding process for error recovery protection. (Hogan Page 1 [0012-0013] and Page 2 [0027])

Regarding claim 35, Uesugi in view of Hogan teaches recovering the power control information in the transmitter via appropriated decoding, with an estimate value being determined for the power control information during the decoding process based on the value obtained by the logic operation from the corresponding bit in the coded data word. (Uesugi Col. 12 line 9 through Col. 13 line 17 and Hogan Page 1 [0012-0013] and Page 2 [0027])

Regarding claim 36, Uesugi in view of Hogan teaches the receiver which produces the coded power control information is a base station in a mobile radio system and the transmitter which received the power control information and sets its transmission level appropriately is a mobile station in the mobile radio system, such that the coded power control information is transmitted via a downlink connection between the receiver and the transmitter. (Uesugi Fig. 4, Fig. 7 and Col. 10 line 13 through Col. 11 line 47)

Regarding claim 37, Uesugi teaches a radio system comprising:

a transmitter; (Fig. 4 [1105]) and

a receiver for receiving a signal from the transmitter (Fig. 4 [Base Station Side]), which is transmitted via a transmission channel of the mobile radio system (Col. 12 lines 21-26), wherein the receiver:

evaluates the received signal; (Col. 12 lines 41-47 and Col. 12 line 57 through Col. 13 line 2)

produce power control information as a function of the signal; (Col. 12 lines 21-26)

embeds the power control information in a time slot structure together with further data to be transmitted in the same timeslot to said transmitter; (Col. 12 line 41 through Col. 13 line 2, Fig. 16A & Fig. 16B)

codes the power control information in one time slot in a manner where the power control information is coded, with the addition of redundancy, together with

further data to be transmitted in the same time slot to form a common data word; and (Col. 19 lines 48-51 and Fig. 16B)

transmits the coded power control information in one timeslot to the transmitter, together with the further data to be transmitted in the same time slot (Fig. 16B and Col. 19 lines 48-51) and wherein the transmitter sets the transmission power as a function of the transmitted coded power control information. (Col. 12 line 41 through Col. 13 line 2)

Uesugi differs from the claimed invention by not explicitly reciting with at least one bit value in the data word depending on the power control information and on the further data.

In an analogous art, Hogan teaches a method and apparatus for performing encryption and error coding correction that includes the usage of an exclusive-OR logic operation (Page 1 [0012-0013] and Page 2 [0027]), wherein once the addition of error correction bits are added to a code word containing power control information and further data, at least one bit value (error correction bit) in the data word is depending on the power control information and on the further data. At the time the invention was made, it would have been obvious to one of ordinary skill in the art to implement the method of power control of Uesugi after modifying it to incorporate the error coding correction of Hogan. One of ordinary skill in the art would have been motivated to do this since it enables a simple error correction that reduces the need for retransmission of lost data. (Page 1 [0003 & 0006])

Regarding claim 38, the limitations of claim 38 are rejected as being the same reason set forth above in claim 26.

Regarding claim 39, the limitations of claim 38 are rejected as being the same reason set forth above in claim 26.

Regarding claim 40, the limitations of claim 40 are rejected as being the same reason set forth above in claim 28.

Regarding claim 41, the limitations of claim 41 are rejected as being the same reason set forth above in claim 29.

Regarding claim 42, the limitations of claim 42 are rejected as being the same reason set forth above in claim 31.

Regarding claim 43, the limitations of claim 43 are rejected as being the same reason set forth above in claim 32.

Regarding claim 45, the limitations of claim 45 are rejected as being the same reason set forth above in claim 34.

Regarding claim 46, the limitations of claim 46 are rejected as being the same reason set forth above in claim 35.

Regarding claim 47, Uesugi in view of Hogan teaches the radio system is a CDMA mobile radio system. (Uesugi Col. 1 lines 15-27)

Regarding claim 48, the limitations of claim 48 are rejected as being the same reason set forth above in claim 36.

Response to Arguments

5. Applicant's arguments with respect to claims 25-48 have been considered but are moot in view of the new ground(s) of rejection.

Conclusion

6. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Matthew C. Sams whose telephone number is (571)272-8099. The examiner can normally be reached on M-F 7:30-5.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Lester Kincaid can be reached on (571)272-7922. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

MCS
4/13/2007

DUC M. NGUYEN
SUPERVISORY PATENT EXAMINER
TECHNOLOGY CENTER 2600

APPENDIX B

Advisory Action dated August 20, 2007.

Advisory Action Before the Filing of an Appeal Brief	Application No. 10/009,858	Applicant(s) RAAF, BERNHARD	
	Examiner Matthew C. Sams	Art Unit 2617	

--The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

THE REPLY FILED 20 July 2007 FAILS TO PLACE THIS APPLICATION IN CONDITION FOR ALLOWANCE.

1. ☒ The reply was filed after a final rejection, but prior to or on the same day as filing a Notice of Appeal. To avoid abandonment of this application, applicant must timely file one of the following replies: (1) an amendment, affidavit, or other evidence, which places the application in condition for allowance; (2) a Notice of Appeal (with appeal fee) in compliance with 37 CFR 41.31; or (3) a Request for Continued Examination (RCE) in compliance with 37 CFR 1.114. The reply must be filed within one of the following time periods:

a) ☒ The period for reply expires 3 months from the mailing date of the final rejection.

b) ☐ The period for reply expires on: (1) the mailing date of this Advisory Action, or (2) the date set forth in the final rejection, whichever is later. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of the final rejection.

Examiner Note: If box 1 is checked, check either box (a) or (b). ONLY CHECK BOX (b) WHEN THE FIRST REPLY WAS FILED WITHIN TWO MONTHS OF THE FINAL REJECTION. See MPEP 706.07(f).

Extensions of time may be obtained under 37 CFR 1.136(a). The date on which the petition under 37 CFR 1.136(a) and the appropriate extension fee have been filed is the date for purposes of determining the period of extension and the corresponding amount of the fee. The appropriate extension fee under 37 CFR 1.17(a) is calculated from: (1) the expiration date of the shortened statutory period for reply originally set in the final Office action; or (2) as set forth in (b) above, if checked. Any reply received by the Office later than three months after the mailing date of the final rejection, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

NOTICE OF APPEAL

2. ☐ The Notice of Appeal was filed on _____. A brief in compliance with 37 CFR 41.37 must be filed within two months of the date of filing the Notice of Appeal (37 CFR 41.37(a)), or any extension thereof (37 CFR 41.37(e)), to avoid dismissal of the appeal. Since a Notice of Appeal has been filed, any reply must be filed within the time period set forth in 37 CFR 41.37(a).

AMENDMENTS

3. ☐ The proposed amendment(s) filed after a final rejection, but prior to the date of filing a brief, will not be entered because
   (a) ☐ They raise new issues that would require further consideration and/or search (see NOTE below);
   (b) ☐ They raise the issue of new matter (see NOTE below);
   (c) ☐ They are not deemed to place the application in better form for appeal by materially reducing or simplifying the issues for appeal; and/or
   (d) ☐ They present additional claims without canceling a corresponding number of finally rejected claims.

   NOTE: _____. (See 37 CFR 1.116 and 41.33(a)).

4. ☐ The amendments are not in compliance with 37 CFR 1.121. See attached Notice of Non-Compliant Amendment (PTOL-324).

5. ☐ Applicant's reply has overcome the following rejection(s): _____.

6. ☐ Newly proposed or amended claim(s) _____ would be allowable if submitted in a separate, timely filed amendment canceling the non-allowable claim(s).

7. ☐ For purposes of appeal, the proposed amendment(s): a) ☐ will not be entered, or b) ☐ will be entered and an explanation of how the new or amended claims would be rejected is provided below or appended.
   The status of the claim(s) is (or will be) as follows:
   Claim(s) allowed: ____.
   Claim(s) objected to: _____.
   Claim(s) rejected: _____.
   Claim(s) withdrawn from consideration: _____.

AFFIDAVIT OR OTHER EVIDENCE

8. ☐ The affidavit or other evidence filed after a final action, but before or on the date of filing a Notice of Appeal will not be entered because applicant failed to provide a showing of good and sufficient reasons why the affidavit or other evidence is necessary and was not earlier presented. See 37 CFR 1.116(e).

9. ☐ The affidavit or other evidence filed after the date of filing a Notice of Appeal, but prior to the date of filing a brief, will not be entered because the affidavit or other evidence failed to overcome all rejections under appeal and/or appellant fails to provide a showing a good and sufficient reasons why it is necessary and was not earlier presented. See 37 CFR 41.33(d)(1).

10. ☐ The affidavit or other evidence is entered. An explanation of the status of the claims after entry is below or attached.

REQUEST FOR RECONSIDERATION/OTHER

11. ☒ The request for reconsideration has been considered but does NOT place the application in condition for allowance because: See Continuation Sheet.

12. ☐ ~~Note the attached Information Disclosure Statement(s). (PTO/SB/08) Paper No(s).~~ _____

13. ☐ Other: _____.

LESTER G. KINCAID
SUPERVISORY PRIMARY EXAMINER

Continuation of 11. does NOT place the application in condition for allowance because: With respect to the applicant's argument regarding "embedding the power control information in a timeslot structure together with further data to be transmittted in the same timeslot" (Page 8), the examiner disagrees. Uesugi clearly teaches in Fig. 16A & 16B a time slot that includes power control information (TPC) and further data (Data of Specified Pattern, D0, D1...D6).

With respect to the applicant's argument regarding "coding" (Page 8), the examiner disagrees.
Uesugi clearly teaches the transmission of symbols and bits (Col. 11 line 15 & 51), which obviously requires a "coding" process to be represented as symbols and bits in order to be transmitted.

With respect to the "addition of redundancy" (Page 8 & 9), it is not clearly claimed what is redundant, therefore the redundancy shown in Fig. 16B and disclosed in Col. 19 lines 46-52 meets the limitation.

With respect to the "further data to be transmitted in the same time slot to form a common data word", Uesugi clearly teaches further data in Fig. 16B [D0, D1 & D6], transmitted as a common data word. (First Slot).

With respect to the "one bit value in the data word depending on the power control information and on the further data" (Page 8 & Page 9), adding a parity bit or error correction control bit is well known in the art. The entire time slot is XOR'd, with the additional bit dependent upon the values of the coded time slot. Hogan clearly teaches the use of XOR logic for performing error coding correction with the addition of an error correction bit. (Page 1 [0012-0013]) Transmitting an error correction bit along with the transmission clearly minimizes repetitive transmissions because the receiver has ability to recover the original information from the noise of the transmission.

In response to applicant's argument that the references fail to show certain features of applicant's invention, it is noted that the features upon which applicant relies (i.e., number of output bits are formed dependent upon the number of input bits" (Page 8)) are not recited in the rejected claim(s). Although the claims are interpreted in light of the specification, limitations from the specification are not read into the claims. See *In re Van Geuns*, 988 F.2d 1181, 26 USPQ2d 1057 (Fed. Cir. 1993).

With respect to the applicant's arguments regarding "encrypted data" (Page 9), an encryption scheme is as simple as representing a 1 as a 1 and a 0 as a -1. (*i.e.* coding for digital communication) In other words, Uesugi obviously already handles "encrypted data", the examiner is just modifying the technique to include an XOR function and adding a bit to the transmission in order to recover the original information.

APPENDIX C

Notice of Panel Decision from Pre-Appeal Brief Review, dated November 19, 2007.

UNITED STATES PATENT AND TRADEMARK OFFICE

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/009,858	12/22/2001	Bernhard Raaf	112740-344	6325

29177 7590 11/19/2007
BELL, BOYD & LLOYD, LLP
P.O. BOX 1135
CHICAGO, IL 60690

EXAMINER	
SAMS, MATTHEW C	

ART UNIT	PAPER NUMBER
2617	

MAIL DATE	DELIVERY MODE
11/19/2007	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Application Number	Application/Control No.	Applicant(s)/Patent under Reexamination	
	10/009,858	RAAF, BERNHARD	
	Lester Kincaid	Art Unit 2617	
Document Code - AP.PRE.DEC			

Notice of Panel Decision from Pre-Appeal Brief Review

This is in response to the Pre-Appeal Brief Request for Review filed 9/20/07.

1. ☐ **Improper Request** – The Request is improper and a conference will not be held for the following reason(s):

   ☐ The Notice of Appeal has not been filed concurrent with the Pre-Appeal Brief Request.
   ☐ The request does not include reasons why a review is appropriate.
   ☐ A proposed amendment is included with the Pre-Appeal Brief request.
   ☐ Other:

The time period for filing a response continues to run from the receipt date of the Notice of Appeal or from the mail date of the last Office communication, if no Notice of Appeal has been received.

2. ☒ **Proceed to Board of Patent Appeals and Interferences** – A Pre-Appeal Brief conference has been held. The application remains under appeal because there is at least one actual issue for appeal. Applicant is required to submit an appeal brief in accordance with 37 CFR 41.37. The time period for filing an appeal brief will be reset to be one month from mailing this decision, or the balance of the two-month time period running from the receipt of the notice of appeal, whichever is greater. Further, the time period for filing of the appeal brief is extendible under 37 CFR 1.136 based upon the mail date of this decision or the receipt date of the notice of appeal, as applicable.

   ☒ The panel has determined the status of the claim(s) is as follows:
   Claim(s) allowed: _____.
   Claim(s) objected to: _____.
   Claim(s) rejected: *25-32, 34-38, 40-43, 45-48*.
   Claim(s) withdrawn from consideration: _____.

3. ☐ **Allowable application** – A conference has been held. The rejection is withdrawn and a Notice of Allowance will be mailed. Prosecution on the merits remains closed. No further action is required by applicant at this time.

4. ☐ **Reopen Prosecution** – A conference has been held. The rejection is withdrawn and a new Office action will be mailed. No further action is required by applicant at this time.

All participants:

LESTER G. KINCAID
SUPERVISORY PRIMARY EXAMINER

(1) *Lester Kincaid*.

(3) *Matt Sams*.

(2) *Tommy Chin*.

(4)_____.

APPENDIX D

Uesugi et al. (EP 0893889), cited by the Examiner in the Final Office Action dated April 20, 2007.

(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 893 889 A2

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(54) Method and apparatus for transmission power control in a CDMA communication system

(57) Pilot symbol 1021 of the first slot and TPC symbol 1022 thereof are transmitted by the same transmission power as that one the commencement of transmission, and the transmission power of data symbol 1023 is made zero. In slots including and after the second slot, pilot symbol 1031 and TPC symbol 1032 are transmitted at the same position as that on the commencement of transmission and by smaller transmission power than that on the commencement of transmission, and further dummy signal 1033 is transmitted, as in the above, by the same transmission power after TPC.

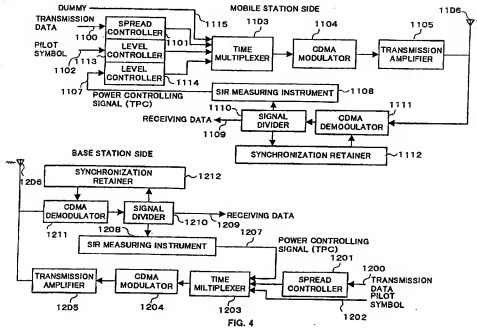


FIG. 4

EP 0 893 889 A2

Description

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a CDMA (code division multiple access) communication system and apparatus, which are used for digital radio communications.

Description of the Related Art

A description is given of prior arts with reference to FIG. 1 through FIG. 3.

FIG. 1 is a configurational view of mobile stations and base station of a conventional CDMA communication system. In FIG. 1, a mobile station of the CDMA communication system comprises of spread controller 101 into which transmission data 100 is inputted, time multiplexer 103 which multiplexes output of the spread controller 101, pilot symbols 102, and power control signals (TPC) described later, CDMA modulator 104, transmission amplifier 105, antenna 106, SIR measurement instrument 108 which outputs the power control signal (TPC) 107 to the time multiplexer 103, signal divider 110 which outputs receiving data 109, CDMA demodulator 111, and synchronization retainer 112.

In other words, the base station of CDMA communication system is composed as in the above. That is, the base station of CDMA communication system is composed of a spread controller 201 into which transmission data 200 is inputted, time multiplexer 203 for multiplexing the output of the spread controller 201, pilot symbol 202, and power control signal (TPC) described later, CDMA modulator 204, transmission amplifier 205, antenna 206, SIR measurement instrument 208 for outputting power control signals (TPC) 207 to the time multiplexer 203, signal divider 210 for outputting receiving data 209, CDMA demodulator 211, and synchronization retainer 212.

A description is given of transmission processing of a mobile station for CDMA communication system, which is constructed as described above. Transmission data 100 is spread controlled by spread controller 101. That is, the transmission data rate is judged, wherein if the rate is low, the transmission data 100 is processed so that a slot having a small amplitude and a long symbol length can be obtained, and if the transmission data rate is great, is processed so that a slot having a large amplitude and a short symbol length can be obtained. The time multiplexer 103 multiplexes the time of the processed results, pilot symbol 102 and power control signal (TPC) 107 obtained by SIR measurement instrument 108, and this is modulated for code division multiple access by CDMA modulator 104, is amplified by transmission amplifier 105 and is transmitted through antenna 106.

For example, in a case where the transmission data rate is high, data symbol 3 is transmitted by the same transmission power as that of pilot symbol 1 and TPC symbol 2 as shown in FIG. 2A. Furthermore, if there is no data even in a case where the transmission data rate is high, as shown in FIG. 2B, pilot symbol 11 and TPC symbol 12 are transmitted by the same transmission power as that on the commencement of transmission. However, as for the data symbol 13, the transmission power is made 0.

On the other hand, in a case where the transmission data rate is low, as shown in FIG. 2C, pilot symbol 21 and TPC symbol 22 are transmitted by the same transmission power as that on the commencement of transmission, and data symbol 23 is transmitted by small transmission power instead of lengthening the time length of the symbol.

Furthermore, in a case where the transmission data rate is low, as shown in FIG. 2D, pilot symbol 31 and TPC symbol 32 are transmitted by the same transmission power as that on the commencement of transmission and data symbol 33 may be transmitted by the same transmission power as the above. In this case, since only a small quantity of data exists, the transmission is stopped halfway.

With the abovementioned transmission method, the quality of data symbols 23 and 33 can be made equivalent to the quality of data symbol 3.

With respect to the entirety of the transmission frames, if the data rate is high, the transmission power pattern becomes as shown in FIG. 3A, and if no data exists, the transmission power pattern becomes as shown in FIG. 3B. If the data rate is low, the transmission power pattern becomes as shown in FIG. 3C and FIG. 3D.

On the other hand, the receiving side of the base station receives data through antenna 206, demodulates the data by CDMA demodulator 211 and separates signals by signal divider 210. Using the pilot symbol, the synchronization retainer 212 retains synchronization, wherein the synchronization is retained so that the received signals can be demodulated in stabilization by CDMA demodulator 211. Furthermore, SIR (signal/interference ratio) of the reverse link circuit is calculated by SIR measurement instrument 208 by using the pilot symbol and TPC symbol. On the basis thereof, power control signal (TPC) 207 which controls the value of the transmission power of the reverse link circuit is calculated.

Furthermore, the processing of transmission at the base station side and reception at a mobile station are the same as those of transmission at the mobile station side and reception at the base station.

As described above, with the conventional CDMA communication system, it is possible to transmit CDMA signals of various rates.

However, in the abovementioned conventional CDMA communication system, in a case where no data exists and the data rate is low, the pattern of transmis-

sion power becomes pulse signals of a specified cycle. Resultantly, linear spectra of great power, which influence other apparatuses, are generated in specified frequency constituents, and such a problem arises, by which adverse influences are exerted onto peripheral devices which are easily subjected to receive influences from cyclic signals.

SUMMARY OF THE INVENTION

It is therefore an object of the invention to provide a CDMA communication system in which no specified cyclic pulse signal is generated even in a case where no transmission data exists and where the transmission data rate is low.

The object is achieved by a CDMA communication apparatus provided with rate judging means which judges the rate of transmission data by the first slot of transmission frame, level controlling means which carries out processing by which the transmission power of transmission control information given to the top of the respective slots after the second slot is made identical to that of the transmission data, and transmission means for transmitting frames processed by uniform transmission power responsive to the result of judgement.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a configurational view of a conventional CDMA communication apparatus;
FIG. 2A to FIG. 2D are diagrams of conventional signal formats;
FIG. 3A to FIG. 3D are diagrams of conventional transmission power patterns;
FIG. 4 is a configurational view of a CDMA communication apparatus according to a first embodiment of the invention;
FIG. 5A to FIG. 5G are diagrams of signal formats used in the first embodiment;
FIG. 6A to 6C are diagrams of transmission power patterns used in the first embodiment;
FIG. 7 is a configurational view of a CDMA communication apparatus according to a second embodiment of the invention;
FIG. 8A to FIG. 8G are diagrams of signal formats used in the second embodiment;
FIG. 9A to FIG. 9C are diagrams of transmission power patterns used in the second embodiment;
FIG. 10 is a configurational view of a CDMA communication apparatus according to a third embodiment of the invention;
FIG. 11A to 11G are diagrams of signal formats used in the third embodiment;
FIG. 12A and FIG. 12B are diagrams of transmission power patterns used in the third embodiment;
FIG. 13 is a configurational view of a CDMA communication apparatus according to a fourth embodiment of the invention;
FIG. 14A to FIG. 14G are diagrams of signal formats used in the fourth embodiment;
FIG. 15A and FIG. 15B are diagrams of transmission power patterns used in the fourth embodiment;
FIG. 16A and FIG. 16B are diagrams of signal formats of the first slot;
FIG. 17 is a configurational view of a CDMA communication apparatus according to a fifth embodiment of the invention; and
FIG. 18A to FIG. 21B are diagrams of signal formats used in the fifth embodiment.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

A CDMA communication apparatus according to the invention comprises a rate judging section which judges the rate of transmission data by the first slot of transmission frame, a level controlling section which carries out processing by which the transmission power of transmission control information given to the top of the respective slots after the second slot is made identical to that of the transmission data, and a transmission section for transmitting frames processed by uniform transmission power responsive to the result of judgement.

With this construction, since it is possible to transmit transmission frames by uniform transmission power even though the transmission data rate is high, or low, or no transmission data exists, generation of specified cyclic pulses can be suppressed, and it is possible to prevent peripheral devices, which are easily subjected to receive influences from cyclic signals, from being adversely influenced.

Furthermore, in the CDMA communication apparatus according to the invention, the level controlling section may be provided with a multiplexing section which multiplexes dummy signals onto transmission frames if no transmission data exists.

With this construction, even though no transmission data is given, it is possible to transmit transmission frames by uniform transmission power. Therefore, generation of specified cyclic pulses can be suppressed, and it is possible to prevent peripheral devices, which are easily subjected to receive influences from cyclic signals, from being adversely influenced.

Furthermore, the CDMA communication apparatus according to the invention may be provided with a rate judging section for judging the transmission data rate by the first slot of transmission frame; a spread controlling section which spreads transmission controlling information, which constitutes the respective slots after the second slot, and transmission data to the entirety of slot; a transmission section for transmitting a frame constituted by a slot spread by uniform transmission power responsive to the result of judgement.

With this construction, the transmission controlling

information and transmission data can be spread to the entirety of slot, and the transmission frame can be transmitted by uniform transmission power. Resultantly, it is possible to suppress generation of specified cyclic pulses, and it is possible to prevent peripheral devices, which are easily subjected to receive influences from cyclic signals, from being adversely influenced.

Furthermore, in the CDMA communication apparatus according to the invention, the spread controlling section may spread the transmission controlling information to the entirety of slot in a case where no transmission data is given.

With this construction, even in a case where no transmission data is given, the transmission controlling information and transmission data can be spread to the entirety of slot, wherein the transmission frame can be transmitted by uniform transmission power. Resultantly, it is possible to suppress generation of specified cyclic pulses, and it is possible to prevent peripheral devices, which are easily subjected to receive influences from cyclic signals, from being adversely influenced. Still furthermore, since it is not necessary for transmit dummy signals, influences exerting onto other users can be suppressed to be low.

In the CDMA communication apparatus according to the present invention, in the case that the rate of the transmission data is low, the transmission section transmits the transmission controlling information and transmission data by the first slot by the same transmission power and control may be carried out so that the transmission is brought to an end immediately after the transmission data is transmitted.

With this construction, even in a case where the transmission data rate is low, since slots including and after the second slot are suppressed by uniform transmission power, generation of specified cyclic pulses is suppressed, and it is possible to prevent peripheral devices, which are easily subjected to receive influences from cyclic signals, from being adversely influenced.

Furthermore, the CDMA communication apparatus according to the invention may be provided with a rate change judging section for judging whether or not the transmission data rate changes, and a transmission controlling sections which, in a case where the rate is not changed, transmits transmission controlling information of the first slot of the next frame by the same transmission power as that of the frame being transmitted, and, in a case where the rate is changed, transmits transmission controlling information of the next first slot by the same transmission power as that on the commencement of transmission, according to the result of judgement.

With this construction, only in a case where the transmission data rate is changed, transmission controlling information is transmitted by the first slot of the respective frames by the same transmission power as that on the commencement of transmission, and in a case where the transmission data rate is not changed, the transmission controlling information and transmission data can be transmitted by uniform transmission power. Resultantly, even in a case where no transmission data is given, generation of pitch signals by frame can be prevented, and generation of specified cyclic pulses can be suppressed. Furthermore, it is possible to prevent peripheral devices, which are easily subjected to receive influences from cyclic signals, from being adversely influenced.

Furthermore, in the CDMA communication apparatus according to the invention, the transmission controlling section may transmit, at random, transmission controlling information of the first slot of transmission frames by the same transmission power as that on the commencement of transmission in a case where transmission is continuously transmitted by the same transmission power.

With this construction, since in a case where transmission is continuously transmitted by the same transmission power the transmission controlling information can be transmitted at random by the same transmission power as that on the commencement of transmission, it is possible to correct an erroneous state even though a mistake arises in the rate judgement when the transmission data rate is changed.

Furthermore, in the CDMA communication apparatus according to the invention, the transmission controlling information may include a pilot symbol and a power controlling signal. With this construction, it is possible to securely carry out transmission receiving of a frame including a plurality of slots.

Furthermore, in the CDMA communication apparatus according to the invention, on the basis of the result of judgement, in a case where no transmission data is given, transmission controlling information of the first slot and specified pattern data can be transmitted by the same transmission power, and in a case where the transmission data rate is low, transmission data may be repeatedly transmitted along with transmission of the transmission controlling information and transmission data.

With this construction, since it is possible to carry out pattern matching at the receiving side, the receiving side can easily judge the transmission data rate in the first slot.

Furthermore, the CDMA communication apparatus is applicable to a mobile station apparatus and a base station apparatus. The mobile station apparatus and base station apparatus constitute a CDMA communication system.

With this construction, even in a case where the transmission data rate is high or low, and where no transmission data is given, transmission frames can be transmitted by uniform transmission power. Therefore, generation of specified cyclic pulses can be suppressed, and it is possible to prevent peripheral devices, which are easily subjected to receive influences from

cyclic signals, from being adversely influenced.

A CDMA communication method according to the invention is able to judge the transmission data rate by the first slot of a transmission frame, and transmit transmission controlling information, which is transmitted by slots including and after the second slot, and transmit transmission data responsive to the result of the abovementioned judgement.

By this method, even in a case where the transmission data rate is high or low, and where no transmission data is given, transmission frames can be transmitted by uniform transmission power. Therefore, generation of specified cyclic pulses can be suppressed, and it is possible to prevent peripheral devices, which are easily subjected to receive influences from cyclic signals, from being adversely influenced.

In the CDMA communication method according to the invention, when no transmission data is given in compliance with the result of judgement, only the transmission controlling information is transmitted by the first slot, wherein the transmission controlling information to be transmitted by slots including and after the second slot may be transmitted by smaller transmission power than the transmission power of the first slot, and dummy signals may be transmitted by the same transmission power as the smaller transmission power.

By this method, in a case where no transmission data is given, it is possible to transmit transmission frames by uniform transmission power. Therefore, generation of specified cyclic pulses can be suppressed, and it is possible to prevent peripheral devices, which are easily subjected to receive influences from cyclic signals, from being adversely influenced.

Furthermore, in the CDMA communication method according to the invention, in a case where the transmission data rate is low in compliance with the result of judgement, the transmission controlling information and transmission data may be transmitted by the first slot, wherein in slots including and after the second slot, the transmission controlling information and transmission data may be transmitted after the sum of the symbol length of the transmission controlling information and transmission data is made equal to the slot length.

By this method, even in a case where the transmission data rate is low, it is possible to make the sum of the symbol length of the transmission controlling information and transmission data equal to the slot length, wherein transmission frames can be transmitted by uniform transmission power. Therefore, generation of specified cyclic pulses can be suppressed, and it is possible to prevent peripheral devices, which are easily subjected to receive influences from cyclic signals, from being adversely influenced.

In the CDMA communication method according to the invention, in a case where the transmission data rate is low in compliance with the result of judgement, the transmission controlling information and transmission data are transmitted by the first slot by the same transmission power, and the transmission may be brought to an end on the way immediately after the transmission of the abovementioned transmission data is finished.

By this method, even in a case where the transmission data rate is low, since slots including and after the second slot are suppressed by uniform transmission power. Therefore, generation of specified cyclic pulses can be suppressed, and it is possible to prevent peripheral devices, which are easily subjected to receive influences from cyclic signals, from being adversely influenced.

Furthermore, in the CDMA communication method according to the invention, in a case where no transmission data is given, only the transmission controlling information is transmitted by the first slot, and the transmission controlling information to be transmitted by slots including and after the second slot may be spread to the entirety of slot for transmission.

By this method, even in a case where no transmission data is given, the transmission controlling information and transmission data can be spread to the entirety of slot and transmission frames can be transmitted by uniform transmission power. Therefore, generation of specified cyclic pulses can be suppressed, and it is possible to prevent peripheral devices, which are easily subjected to receive influences from cyclic signals, from being adversely influenced. Still furthermore, since it is not necessary to transmit any dummy signal, influences exerted onto other users can be suppressed to be low.

Furthermore, in the CDMA communication method according to the invention, in a case where the transmission data rate is low in compliance with the result of judgement, the transmission controlling information and transmission data are transmitted by the first slot and the transmission controlling information and transmission data may be spread to the entirety of slot for transmission in slots including and after the second slot.

By this method, the transmission controlling information and transmission data in slots including and after the second slot can be spread to the entirety of slot, and transmission frames can be transmitted by uniform transmission power. Therefore, generation of specified cyclic pulses can be suppressed, and it is possible to prevent peripheral devices, which are easily subjected to receive influences from cyclic signals, from being adversely influenced.

Furthermore, in the CDMA communication method according to the invention, in a case where no transmission data is given in compliance with the result of judgement, transmission controlling information and specified pattern data may be transmitted by the first slot by the same transmission power. Furthermore, in the CDMA communication method according to the invention, in a case where the transmission data rate is low in compliance with the result of judgement, the same transmission data may be further repeatedly transmitted along with the transmission of transmission controlling infor-

mation and specified pattern data by the first slot.

By such a method, it is possible to carry out pattern matching at the receiving side. Resultantly, the receiving side is able to easily judge the transmission data rate at the first slot.

Furthermore, in the CDMA communication method according to the invention, it is judged whether or not the transmission data rate changes. If not changed, the transmission controlling information of the first slot of the next frame is transmitted by the same transmission power as that of the frame being transmitted, and if changed, the transmission controlling information of the next first slot may be transmitted by the same transmission power as that on the commencement of transmission.

By this method, only in a case where the transmission rate is changed, the transmission controlling information is transmitted by the first slot of the respective frames by the transmission power which is available on the commencement of transmission, and in a case where the transmission rate is not changed, the transmission controlling information and transmission data can be transmitted by uniform transmission power. Therefore, in a case where a silent state is continued, that is, no transmission data is given, it is possible to prevent by-frame pitch signals from being generated, and generation of specified cyclic pulses can be suppressed, and it is possible to prevent peripheral devices, which are easily subjected to receive influences from cyclic signals, from being adversely influenced.

Still furthermore, in the CDMA communication method according to the invention, when transmission is continuously carried out by the same transmission power, the transmission controlling information of the first slot of a transmission frame may be transmitted, at random, by the same transmission power as that on the commencement of transmission.

By this method, in a case where transmission is continuously carried out by the same transmission power, it is possible to transmit transmission controlling information at random by the transmission power which is available on the commencement of transmission. Therefore, even though the judgement is erroneous when the transmission rate is changed, this erroneous state can be corrected.

Furthermore, in the CDMA communication method according to the invention, the transmission controlling information may include a pilot symbol and a power controlling signal. By this method, it is possible to securely carry out transmission and receiving, which are composed of a plurality of slots.

Hereinafter, a detailed description is given of preferred embodiments of the invention with reference to the accompanying drawings.

(Embodiment 1)

In the first embodiment of the invention, a description is given of a case where a pilot symbol and a TPC (power controlling signal) symbol are transmitted to a fixed position at a fixed transmission power in only the top slot of a frame, not depending on a rate, symbols other than the above are transmitted in response to the rate, and further in slots including and after the second slot, a pilot symbol and a TPC (power controlling signal) symbol are transmitted by a transmission power responsive to the data rate along with data without changing the positions thereof. Thereby, generation of pulses in every slot can be prevented, wherein unnecessary linear spectra can be suppressed.

FIG. 4 is a configurational view showing a mobile station apparatus and a base station apparatus of a CDMA communication system according to the first embodiment. In FIG. 4, a mobile station of the CDMA communication system is mainly composed of a spread controller 1101 into which transmission data 1100 is inputted; a level controller 1113 into which pilot symbol 1102 is inputted; a level controller 1114 into which power controlling signal (TPC) 1107 is inputted; a time multiplexer 1103 for multiplexing the output of spread controller 1101, level controller 1113, and level controller 1114, with dummy signal 1115; a CDMA modulator 1104; a transmission amplifier 1105; an antenna 1106; an SIR measurement instrument 1108 for outputting the power controlling signal (TPC) 1107 to the time multiplexer 1103; a signal divider 1110 for outputting receiving data 1109; a CDMA demodulator 1111; and a synchronization retainer 1112.

On the other hand, a base station of the CDMA communication system is mainly composed of a spread controller 1201 into which transmission data 1200 is inputted; a time multiplexer 1203 for multiplexing the output of spread controller 1201, pilot symbol 1202, and power controlling signal (TPC) 1207 described later; a CDMA modulator 1204; a transmission amplifier 1205; an antenna 1206; an SIR measurement instrument 1208 for outputting the power controlling signal (TPC) 1207 to time multiplexer 1203; a signal divider 1210 for outputting receiving data 1209; a CDMA demodulator 1211; and a synchronization retainer 1212.

Next, a description is given of transmission processing of a mobile station. Transmission data 1100 is controlled for spread by spread controller 1101. That is, if the transmission rate is low, the data is processed so that the same has a small amplitude and a long symbol length, and if the transmission rate is high, the data is processed so that the same has a large amplitude and a short symbol length.

The amplitude of pilot symbol 1102 is processed by level controller 1113 so as to have the same amplitude as that of the data, and the amplitude of power controlling signal (TPC) 1107 is processed by level controller 1114 so as to have the same amplitude as that of the data. In time multiplexer 1103, time multiplexing is given to these results and dummy signals 1115, and this is CDMA-modulated by CDMA modulator 1104 and ampli-

fied by transmission amplifier 1105. Thereafter, the same is transmitted through antenna 1106.

Next, a description is given of signal format with reference to FIG. 5, wherein a plurality of slots are defined to be a frame, and it is assumed that the transmission rate is fixed in a frame. In a case where the transmission data rate is high, as shown in FIG. 5A, pilot symbol 1001, TPC symbol 1002 and data symbol 1003 are transmitted by the same transmission power in only the first slot. In this case, as shown in FIG. 5B, pilot symbol 1011, TPC symbol 1012 and data symbol 1013 are transmitted by the same transmission power in slots including and after the second slot. Furthermore, if no transmission data is given, as shown in FIG. 5C, the pilot symbol 1021 and TPC symbol 1022 of the first slot are transmitted by the same transmission power as that on the commencement of transmission, the transmission power of the data symbol 1023 is made zero.

On the other hand, as shown in FIG. 5D, in a case where no data is given, pilot symbol 1031 and TPC symbol 1032 are transmitted in slots including and after the second slot at the same position as that shown in FIG. 5A by smaller transmission power than that shown in FIG. 5A, and a dummy signal is further transmitted, as in the above, by the same transmission power after the TPC.

Furthermore, if the transmission rate is low, as shown in FIG. 5E, pilot symbol 1041 and TPC symbol 1042 of the first slot are transmitted by the same transmission power as that on the commencement of transmission, and with respect to data symbol 1043, the same is transmitted by small transmission power instead of lengthening the time length of symbol.

Furthermore, if the data rate is low, as shown in FIG. 5F, pilot symbol 1061, TPC symbol 1062, and data symbol 1063 are transmitted by the same transmission power as that on the commencement of transmission, and the transmission may be brought to an end on the way since data is a little.

Still furthermore, if the transmission rate is low, as shown in FIG. 5G, pilot symbol 1051, TPC signal 1052 and data symbol 1053 are transmitted by the same transmission power for slots including and after the second slot so as to make the sum of the symbol length equal to the slot length, wherein the transmission power may be adjusted so that the quality of the data symbol 1053 is made the same as that of the data symbol 1003.

Next, a description is given of the entirety of frame with reference to FIG. 6. If the data rate is high, the transmission power pattern becomes as shown in FIG. 6A, and the transmission power of transmission bit 1071 becomes the same as that of the data 1073. If no data is given, the transmission power pattern becomes as shown in FIG. 6B, wherein the transmission power of the transmission power bit 1071 and empty data 1072 in slots including and after the second slot is low while the transmission power of only the transmission controlling bit 1071 of the first slot is high. In a case where the data rate is low, the transmission power pattern becomes as shown in FIG. 6C, wherein the transmission power of the transmission controlling bit and data 1073 in slots including and after the second slot is low while the transmission power of only the transmission controlling bit 1071 of the first slot is high. In either case, the transmission power is made uniform in slots including and after the second slot.

From the above, since no cyclic signal repeating by slot time exists in any data rate, it is possible to prevent peripheral devices, which are easily subjected to receive influences from cyclic signals, from being adversely influenced.

On the other hand, the receiving side of a base station receives data through antenna 1206, demodulates by CDMA demodulator 1211, and separates signals by signal divider 1210. Using the pilot symbol, synchronization retainer 1212 retains synchronization, wherein the synchronization can be retained so that the received signals are stably demodulated by CDMA demodulator 1211. Furthermore, using the pilot symbol and TPC symbol, SIR (signal/interference ratio) of the reverse link circuit is calculated by SIR measurement instrument 1208. On the basis thereof, the power controlling signal (TPC) 1207 which controls the value of the transmission power of the reverse link circuit is calculated.

Furthermore, the transmission at the base station side and receiving the mobile station side are similar to the transmission at the base station side and receiving at the mobile station side according to prior art. Furthermore, since such a problem by which peripheral devices influenced by cyclic signals are adversely influenced, arises in only the reverse link circuit, signals in the forward link circuit are processed as before.

Transmission data 1200 is spread-controlled by spread controller 1201. That is, if the transmission data rate is low, the transmission data is processed so that the same has a small amplitude and a long symbol length, and if the transmission data rate is high, the transmission data is processed so that it has a large amplitude and a short symbol length. As a result, the time multiplexer 1203 multiplexes the pilot symbol 1202 and the power controlling signal (TPC) 1207 obtained by SIR measurement instrument 1208, the transmission data is CDMA-modulated by CDMA modulator 1204, is amplified by transmission amplifier 1205, and is transmitted through antenna 1206.

The receiving side of a mobile station receives data through antenna 1106, demodulates the same by CDMA demodulator 1111, and separates signals by signal divider 1110. Synchronization retainer 1112 retains synchronization by using pilot symbols, wherein synchronization is retained so that the received signals can be stably demodulated by CDMA demodulator 1111. Furthermore, using the pilot symbols and TPC symbols, SIR (signal/interference ratio) of the reverse link circuit is calculated by SIR measurement instrument 1108. On the basis thereof, the power controlling signal (TPC)

1107 which controls the value of transmission power of the reverse link circuit is calculated.

As described above, since the pilot symbol and power controlling signal of the first slot are fixed regardless of rate, it is possible to carry out the SIR measurement and power control of the section without any delay. Furthermore, by measuring the transmission power of the section coming after the TPC of the first slot, it is possible to judge the rate of transmission data. Therefore, in slots including and after the second slot, the transmission control can be carried out by using the result of judgement, and it is possible to prevent cyclic pulses from being generated due to the pilot symbols and TPC at every slot. Resultantly, it is possible to prevent peripheral devices, which are subjected to receive influences by cyclic signals, from being adversely influenced thereby.

(Embodiment 2)

In the second embodiment of the invention, a description is given of a case where a pilot symbol and a TPC (power controlling signal) symbol are transmitted to a fixed position at a fixed transmission power in only the top slot of a frame, not depending on a rate, symbols other than the above are transmitted in response to the rate, and further in slots including and after the second slot, data of the pilot symbol and TPC (power controlling signal) symbol are transmitted by the transmission power and symbol time responsive to the data rate. Thereby, generation of pulses in every slot can be prevented, wherein unnecessary linear spectra can be suppressed, and it is possible to transmit pilot signals and TPC at a sufficient quality.

FIG. 7 is a configurational view showing a mobile station and a base station of the CDMA communication system according to the second embodiment. In FIG. 7, spread controllers 2113, 2114 are provided instead of level controllers 1113, 1114 constructed as shown in FIG. 4. All the other construction is the same as that shown in FIG. 4, and the description thereof is omitted.

A description is given of a transmission processing of a mobile station of the CDMA communication system according to the second embodiment constructed as described above. Transmission data 1100 is spread-controlled by spread controller 1101. That is, if the transmission data rate is low, the transmission data is processed so as to have a small amplitude and a longer symbol length, and if the transmission data rate is high, the transmission data is processed so as to have a large amplitude and a short symbol length. The pilot symbol 2102 and power control signal 1107 are spread to the entirety of transmission slot along with the transmission data by spread controllers 2113, 2114.

Time multiplexer 1103 multiplexes the output of the abovementioned spread controllers 1101, 2113, 2114 and the multiplexed outputs are CDMA modulated by CDMA modulator 1104, amplified by transmission amplifier 1105 and transmitted through antenna 1106.

Next, a description is given of signal format with reference to FIG. 8. Herein, a plurality of slots are defined to be a frame, and it is assumed that the transmission rate is fixed in a frame. If the transmission data frame is high, as shown in FIG. 8A, in only the first slot, pilot symbol 2011, TPC symbol 2012, and data symbol 2013 are transmitted by the same transmission power. In this case, in slots including and after the second slot, as shown in FIG. 8B, pilot symbol 2001, TPC symbol 2002, and data symbol 2003 are transmitted by the same transmission power.

Furthermore, if no transmission data is given, as shown in FIG. 8C, pilot symbol 2021 and TPC symbol 2022 of the first slot are transmitted by the same transmission power as that on the commencement of transmission, and the transmission power of data symbol 2023 is made zero. On the other hand, as shown in FIG. 8D, if no data is given, pilot symbol 2031 and TPC symbol 2032 are spread to the entirety of slot in slots including and after the second slot, and they are transmitted by smaller transmission power than in the case shown in FIG. 8A.

Furthermore, if the data rate is low, as shown in FIG. 8E, pilot symbol 2041 and TPC symbol 2042 of the first slot are transmitted by the same transmission power as that on the commencement of transmission, wherein data symbol 2043 is transmitted with small transmission power instead of lengthening the symbol time length. Thereby, the quality of data symbol 2043 can be made equivalent to that of data symbol 2013.

Furthermore, if the data rate is low, as shown in FIG. 8F, pilot symbol 2061 and TPC symbol 2062 may be transmitted by the same transmission power as that on the commencement of transmission and data symbol 2063 may be transmitted by the same transmission power. In this case, since the data is a little, the transmission is brought to an end on the way. Thereby, the quality of data symbol 2063 can be made equal to that of data symbol 2013.

Furthermore, if the data rate is low, as shown in FIG. 8G, pilot symbol 2051, TPC signal 2052, and data symbol 2053 are transmitted by the transmission power in slots including and after the second slot, and the symbol length is processed so that the sum of these lengths becomes a slot length. Furthermore, the transmission power is adjusted so that the quality of data symbol 2053 becomes the same as that of data symbol 2013.

Next, a description is given of the entirety of a frame with reference to FIG. 9. If the data rate is high, the transmission power pattern becomes as shown in FIG. 9A, wherein the transmission power of transmission controlling bit 2071 becomes the same as that of data 2073. If no data is given, the transmission power pattern becomes as shown in FIG. 9B, wherein the transmission power of only the transmission controlling bit 2071 of the first slot is high, and the transmission power of the transmission power bit 2071 of slots including and after

the second slot is low. If the data rate is low, the transmission power pattern becomes as shown in FIG. 6C, wherein the transmission power of only the transmission controlling bit 2071 of the first slot is high, and the transmission power of the transmission controlling bit 2071 and data 2073 of slots including and after the second slot is low. In any case, the transmission power of slots including and after the second slot becomes uniform. Furthermore, since the processing of a base station is identical to that of the first embodiment, the description thereof is omitted.

From the above description, since there is no cyclic signal repeating in the slot time in any data rate, it is possible to prevent peripheral devices, which are subjected to receive influences from cycle signals, from being adversely influenced.

(Embodiment 3)

In the third embodiment, a description is given of a case where pilot symbol and TPC (power controlling signal) symbol are transmitted by a fixed transmission power to a fixed position in the top slot of frame, not depending on the rate, all the other symbols are transmitted in response to rates, and further pilot symbol and TPC (power controlling signal) symbol are transmitted by transmission power responsive to the data rate along with data without changing the positions thereof.

Thereby, it is possible to prevent pulses from occurring slot by slot, wherein unnecessary linear spectra can be suppressed. Furthermore, even in a case where a state where no data is given is continued, it is possible to suppress frame-by-frame linear spectra due to cyclic signals by causing irregular pulses not to be produced.

FIG. 10 is a configurational view showing a mobile station and a base station of the CDMA communication system according to the third embodiment. In FIG. 10, frame counters 3116, 3216 and pattern storing section 3115, 3215 are added to the construction shown in FIG. 4.

These frame counters 3116, 3216 are for counting to which frame of super frame the frame belongs, which transmits pilot symbol and TPC (power controlling signal) symbol (transmission controlling information) of the first slot at random by the same transmission power as that on the commencement of transmission. Frame counter 3216 in the base station independently operates. On the other hand, frame counter 3116 in a mobile station acquires synchronization by synchronization retainer 3112 and is caused to operate on the basis of the synchronization signal. Therefore, the same is in synchronization with frame counter 3216 in the base station.

Furthermore, pattern storing section 3115 at the mobile station side and that at the base station side are of the same construction. Pattern storing section 3115, 3215 stores, in memory, whether or not special format is used in the first slot even in a case where the same rate is continued. Here, the special format section a signal format in a case where the transmission controlling information is transmitted by the same transmission power as that on the commencement of transmission.

Spread controller 1101,, level controller 1113, and level controller 1114 control a format in compliance with the output of pattern storing section 3115.

Furthermore, synchronization retainer 1212 at the base station side is constructed so that the same can generate a receiving timing in compliance with the output pattern storing section 3215 and accurately receive the reverse link signal by CDMA demodulator 1211. All the other construction is identical to that of the first embodiment. Therefore, the description thereof is omitted.

In the first embodiment, if a silent state is continued since a special format is applied in all the first slots, there is a case where a frame-by-frame pitch signal is generated. Therefore, in the third embodiment, a special format is employed in the first slot in only a case where the transmission rate is changed.

However, if it is assumed that the transmission rate is erroneous when the signal rate is changed, the state is continued until the rate is changed next. Therefore, a special format is employed for the first slot in specified frames even though the signal rate is not changed. That is, the transmission controlling information of the first slot is transmitted at random by the transmission power which is available on the commencement of transmission. A pattern of a unit of super frame in which a plurality of frames are composed as a unit is employed to this pattern, and a random pattern is employed, in which super frame is used as a cycle. Thereby, it is possible to suppress components having frame-by-frame pitches when the same rate is continued in the first embodiment.

Next, a description is given of signal format with reference to FIG. 11, wherein a plurality of slots are defined to be a frame, and it is assumed that the transmission rate is fixed in a frame.

In a case where the rate of the transmission data is high, as shown in FIG. 11A, pilot symbol 3001, TPC symbol 3002 and data symbol 3003 are transmitted by the same transmission power in only the first slot. In this case, in slots including and after the second slot, pilot symbol 3011, TPC symbol 3012 and data symbol 3013 are transmitted by the same transmission power as shown in FIG. 11B. Furthermore, if no data is given, pilot symbol 3021 and TPC symbol 3022 are transmitted by the same transmission power as that on the commencement of transmission as shown in FIG. 11C, and the transmission power of the data symbol 3023 is made zero.

On the other hand, as shown in FIG. 11D, in slots including and after the second slot where no data is given, pilot symbol 3031 and TPC 3032 are transmitted at the same position as that shown in FIG. 11A and by smaller transmission power than that shown in FIG.

11A. Still furthermore, dummy signal 3033 is transmitted, as in the above, by the same transmission power after the TPC is transmitted.

Furthermore, if the data rate is low, pilot symbol 3041 and TPC symbol 3042 of the first slot are transmitted by the same transmission power as that on the commencement of transmission as shown in FIG. 11E, and the data symbol 3043 is transmitted by small transmission power instead of lengthening the symbol time length.

Furthermore, if the data rate is low, pilot symbol 3061, TPC symbol 3062 and data symbol 3063 may be transmitted by the same transmission power as that on the commencement of transmission as shown in FIG. 11F. In this case, the transmission is brought to an end on the way since the data is a little.

Still furthermore, if the data rate is low, in slots including and after the second slot, pilot symbol 3051, TPC symbol 3052 and data symbol 3053 are transmitted by the same transmission as shown in FIG. 11G so that the sum of the symbol lengths becomes a slot length, wherein the transmission power may be adjusted so that the quality of the data symbol 3053 becomes equivalent to that of data symbol 3003.

Next, a description is given of the entirety of frame with reference to FIG. 12. As shown in FIG. 12A, since the data rate is changed when shifting from the first frame 3001 being a sound range to the second frame 3002 being a silent range, a special format is employed for the first slot of the second frame.

Since the data rate is not changed from when shifting from the second frame 3002 to the third frame 3003, no special format is employed for the first slot of the third frame. For this reason, even in a case where no data is given, the transmission controlling information is able to prevent pulse-like signals from being generated. Although the data rate is not changed when shifting from the third frame 3003 to the fourth frame 3004, a special format is employed for the first slot of the fourth frame. Thereby, even though the rate judgement is made erroneous, the correction is possible.

Since the data rate is changed when shifting from the fourth frame 3004 to the fifth frame 3005, a special format is employed for the first slot of the fifth frame. Furthermore, as shown in FIG. 12B, in a case where a silent state is continued, transmission controlling information is transmitted at random in the first slot of the respective frames by the transmission power which is available on the commencement of transmission. Therefore, even though the rate judgement is made erroneous, the correction is possible.

(Embodiment 4)

In the fourth embodiment, a description is given of a case where pilot symbol and TPC (power controlling signal) symbol are transmitted to a fixed position by a fixed transmission power regardless of the rate, and all the other symbols are transmitted in response to the rate, and further in slots including and after the second slot, pilot symbol and TPC (power controlling signal) symbol are transmitted by the transmission power responsive to the data rate along with data without changing the positions thereof.

Thereby, it is possible to prevent pulses from being generated in every slot. Furthermore, pilot symbol and TPC can be transmitted at a sufficient quality, and even in a case where a data-free state is continued, it is possible to suppress linear spectra due to frame-by-frame cyclic signals by preventing irregular pulses from being generated.

FIG. 13 is a configurational view showing a mobile station and a base station of the CDMA communication system according to the fourth embodiment. In FIG. 13, frame counters 4116, 4216 and pattern storing section 4115, 4215, shown in FIG. 10, are added to the construction shown in FIG. 7. The frame counters 4116, 4216 and pattern storing section 4115, 4215 are identical to those in the third embodiment.

Next, a description is given of signal format with reference to FIG. 14. In the fourth embodiment, if the transmission data rate is high, pilot symbol 4011, TPC symbol 4012 and data symbol 4013 are transmitted in only the first slot by the same transmission power as shown in FIG. 14A. In this case, As shown in FIG. 14B, pilot symbol 4001, TPC symbol 4002 and data symbol 4003 are transmitted by the same transmission power in slots including and after the second slot.

Furthermore, if no transmission data is given, pilot symbol 4021 and TPC symbol 4022 of the first slot are transmitted by the same transmission power as that on the commencement of transmission as shown in FIG. 14C, and the transmission power of the data symbol 4023 is made zero. On the other hand, if no data is given as shown in FIG. 14D, pilot symbol 4031 and TPC symbol 4032 are spread to the entirety of slot in slots including and after the second slot, and they are transmitted by small transmission power in comparison with the case shown in FIG. 14A.

Furthermore, if the data rate is low, pilot symbol 4041 and TPC symbol 4042 of the first slot are transmitted by the same power as that on the commencement of transmission as shown in FIG. 14E, wherein the data symbol 4043 is transmitted by small transmission power instead of lengthening the symbol time length. Thereby, the quality of the data symbol 4043 is made equivalent to that of the data symbol 4013.

Furthermore, if the data rate is low, pilot symbol 4061 and TPC symbol 4062 are transmitted by the same power as that on the commencement of transmission as shown in FIG. 14F, and the data symbol 4063 may be transmitted by the same transmission power. In this case, the transmission is brought to an end on the way since the data is a little. Thereby, the quality of the data symbol 4063 is made equivalent to that of the data symbol 4013.

Furthermore, if the data rate is low, pilot symbol 4051, TPC signal 4052 or data symbol 4053 is transmitted by the same transmission power in slots including and after the second slot as shown in FIG. 14G, and the symbol length is processed so that the sum of these lengths becomes the slot length. Furthermore, the transmission power is adjusted so that the quality of the data symbol 4053 is made equivalent to that of the data symbol 4013.

Next, a description is given of the entirety of frame with reference to FIG. 15. As shown in FIG. 15A, since the data rate is changed when shifting from the first frame 4001 being a sound range to the second frame 4002 being a silent range, a special format is employed for the first slot of the second frame. Since the data rate is not changed when shifting from the second frame 4002 to the third frame 4003, no special format is employed for the first slot of the third frame. For this reason, even in a case where no data is given, the transmission controlling information is able to prevent pulse-like signals from being generated.

Although the data rate is not changed when shifting from the third frame 4003 to the fourth frame 4004, a special format is employed for the first slot of the fourth frame. Thereby, even though the rate judgement is made erroneous, the correction can be carried out. Since the data rate is changed when shifting from the fourth frame 4004 to the fifth frame 4005, a special format is employed for the first slot of the fifth frame. Furthermore, as shown in FIG. 15B, in a case where a silent state is continued, the transmission controlling information is transmitted at random in the first slot of the respective frames by the transmission power which is available on the commencement of transmission. Therefore, even though the rate judgement is made erroneous, the correction can be carried out.

Although a description was given of a processing after the second slot of the transmission frames, the following processing is carried out with respect to the first slot.

Firstly, the spread controller judges the rate of transmission data. If no transmission data is given as a result, the transmission controlling information and specified pattern data are transmitted by the same transmission power as shown in FIG. 16A.

Furthermore, the transmission data rate is low, the same data as the transmission data is repeatedly transmitted along with the transmission controlling information. For example, as shown in FIG. 16B, when the data rate is one half, the same data symbol is repeatedly transmitted two times. At this time, data symbol may be reversed at every time, for example, from 0, 1 to 1, 0.

By carrying out the abovementioned process, specified pattern data is transmitted by an empty section of a slot, and the receiving side ensures matching with the pattern. Thereby, it can be easily judged that no data is given in the receiving frame. Furthermore, by the same transmission data being repeated, the receiving side is able to judge that the transmission data rate is low. This is because, by regularly repeating transmission of the same data when the rate is low since the data is transmitted at random if the transmission data rate is high, it is possible to clearly distinguish HIGH and LOW of the data rate. Furthermore, in addition to the abovementioned method, a similar effect can be obtained by transmitting the transmission controlling information of the first slot with a transmission data rate given thereto.

(Embodiment 5)

In the fifth embodiment, a description is given of a case where pilot symbol and TPC (power controlling signal) symbol are transmitted while being code-divided and multiplexed with respect to data. Thereby, the spread ratio of pilot symbols and TPC symbols is increased while the power is decreased. Therefore, it is possible to prevent the transmission power from being turned on and off when transmitting the pilot symbols and TPC symbols.

FIG. 17 is a configuration view showing a mobile station and a base station of the CDMA communication system according to the fifth embodiment. In FIG. 17, multiplexers 5103, 5203 are provided instead of time multiplexers 2103, 2203 in the construction shown in FIG. 7. Since the other construction is identical to that shown in FIG. 7, the description thereof is omitted.

A description is given of a transmission processing of a mobile station of the CDMA communication system according to the fifth embodiment, which is constructed as shown above. Transmission data 1100 is spread-controlled by spread controller 1101. That is, if the transmission data rate is low, the data is processed so that the same has a small amplitude and a long symbol length, and if the transmission data rate is high, the data is processed so that the same has a large amplitude and a short symbol length, wherein pilot symbol 2102 and power controlling signal 1107 are spread to the entirety of transmission slot along with the transmission data by spread controllers 2113, 2114.

Multiplexer 5103 multiplexes the outputs of the abovementioned spread controllers 1101, 2113, 2114, wherein the multiplexed output is CDMA-modulated by CDMA modulator 1104, amplified by transmission amplifier 1105, and transmitted through antenna 1106. The base station side multiplexes the output of the abovementioned spread controller 1201, pilot symbol 1202, and TPC 1207 when they are transmitted, wherein the multiplexed output is CDMA-modulated by CDMA modulator 1204, amplified by transmission amplifier 1205 and transmitted through antenna 1206.

Next, a description is given of signal format with reference to FIG. 18 through FIG. 21. Herein, a plurality of slots are defined to be a frame, and it is assumed that the transmission rate is fixed in a frame.

In the embodiment, pilot symbol and TPC (power controlling signal) symbol are transmitted while being

code-divided and multiplexed with respect to data. That is, as shown in FIG. 18, pilot symbol and TPC symbol, the spread ratio is increased with the power decreased are placed onto data.

If no transmission data is given, pilot symbol 5001 and TPC symbol are spread by code 0 having a comparatively large spread ratio as shown in FIG. 18A. Thereby, pilot symbol 5001 and TPC symbol are continuously transmitted. Therefore, it is possible to make the transmission power of the pilot symbol small, wherein it is possible to prevent the pilot symbol from being cyclically transmitted.

On the other hand, as shown in FIG. 18B, if data is given, pilot symbol 5001 spread by code 0 and data 5002 spread by code 1 are multiplexed. Furthermore, in cases shown in FIG. 18A and FIG. 18B, it is assumed that the power of pilot symbol is fixed at all times.

In this embodiment, the phases of pilot symbol and TPC symbol may be changed per symbol. That is, as shown in FIG. 19, phases a to d of pilot symbols 5011 to 5014 are changed in one slot in compliance with a predetermined pattern. Thus, by setting so that the phases of pilot symbols fluctuate, the cycle of repeating pattern can be lengthened. As a result, it is possible to make the transmission power of pilot symbols small, and simultaneously it is possible to further efficiently prevent pilot symbols from being cyclically transmitted.

Furthermore, in this embodiment, the power of pilot symbols and TPC symbols may be changed in response to the transmission rate. That is, in a case where the transmission rate of data 5021 is low, the power of pilot symbols 5001 is made small as shown in FIG. 20A, and in a case where the transmission rate of data 5002 is high, the power of pilot symbols 5022 is increased as shown in FIG. 20B. Thereby, the quality of signals can be further improved in a case where the transmission rate is high, wherein it is possible to lower the total quantity of interference in the system.

Furthermore, in this embodiment, data may be time-multiplexed by pilot symbols while always transmitting code-multiplexed pilot symbols and TPC symbols. That is, as shown in FIG. 21A, if no data is given, code-multiplexed pilot symbols and TPC symbols are always transmitted. On the other hand, as shown in FIG. 21B, if there is data, pilot symbols 5031 spread by code 1 which spreads data is given to the top of data. Therefore, if data is given, the line quality can be further improved, and it is possible to lower the total quantity of interference in the system while maintaining the quality of data. Furthermore, since the transmission power of pilot symbols can be made small, it is possible to prevent peripheral devices, which are subjected to receive influences from cyclic signals, from being adversely influenced.

Furthermore, since the processing of the base station is identical to that of the first embodiment, the description thereof may be omitted.

With respect to the abovementioned first to fifth embodiments, it is possible to constitute the invention in various combinations thereof.

As been made clear from the abovementioned description, according to the present invention, even in cases where the transmission data rate is high, low or no transmission data is given, since the transmission frame can be transmitted by uniform transmission power, generation of specified cyclic pulses can be suppressed, and it is possible to prevent peripheral devices, which are subjected to receive influences from cyclic signals, from being adversely influenced.

Furthermore, even in a case where the transmission data rate is low, it is possible to make the sum of symbol lengths of the transmission controlling information and transmission data equal to the slot length and to transmit the transmission frame by uniform transmission power. For this reason, generation of specified cyclic pulses can be suppressed, and it is possible to prevent peripheral devices, which are subjected to receive influences from cyclic signals, from being adversely influenced.

Furthermore, in a case where the transmission data rate is low, the transmission may be brought to an end immediately after the transmission of the transmission data of the first slot is finished. In this case, generation of specified cyclic pulses can be suppressed, and it is possible to prevent peripheral devices, which are subjected to receive influences from cyclic signals, from being adversely influenced.

In a case where no transmission data is given, the transmission controlling information and transmission data can be spread to the entirety of slot and the transmission frame can be transmitted by uniform transmission power. For this reason, generation of specified cyclic pulses can be suppressed, and it is possible to prevent peripheral devices, which are subjected to receive influences from cyclic signals, from being adversely influenced. Since it is not necessary to transmit dummy signals, influences exerted onto the other users can be suppressed to be low.

Furthermore, the transmission controlling information and transmission data in slots including and after the second slot can be spread to the entirety of slot, and the transmission frame can be transmitted by uniform transmission power. Therefore, generation of specified cyclic pulses can be suppressed, and it is possible to prevent peripheral devices, which are subjected to receive influences from cyclic signals, from being adversely influenced.

The transmission controlling information is transmitted by the first slot of the respective frames by the transmission power which is available on the commencement of transmission in only a case where the transmission rate is changed, and in a case where the transmission rate is not changed, the transmission controlling information and transmission data can be transmitted by uniform transmission power. For this reason, in a case where a silent state is continued, that is, even

in a case where no transmission data is given, it is possible to prevent frame-by-frame pitch signals from being generated, wherein generation of specified cyclic pulses can be suppressed, and it is possible to prevent peripheral devices, which are subjected to receive influences from cyclic signals, from being adversely influenced.

Since the transmission controlling information is transmitted at random by the transmission power which is available on the commencement of transmission in a case where transmission is continuously carried out by the same transmission power, any erroneous state can be corrected even though the transmission rate judgement is made erroneous when the transmission rate is changed.

Furthermore, since it is possible to carry out pattern matching at the receiving side, the receiving side is able to easily judge the transmission data rate in the first slot.

Claims

1. A CDMA communication apparatus comprising;

   rate judging means for judging a transmission data rate in the first slot of a transmission frame;
   level controlling means(1113,1114) for carrying out a process by which the transmission power of transmission controlling information given to the top of each slot in slots including and after the second slot is made identical to a transmission power of transmission data; and
   transmitting means for transmitting said frame processed by uniform transmission power in response to said rate judging means.

2. The CDMA communication apparatus according to claim 1, wherein said level controlling means is provided with multiplexing means(1103) for multiplexing a dummy signal onto the transmission frame in a case where no transmission data is given.

3. A CDMA communication apparatus comprising;

   rate judging means for judging a transmission data rate in the first slot of a transmission frame;
   spread controlling means(1101) for spreading transmission controlling information, which constitutes the respective slots including and after the second slot, and transmission data to the entirety of slot; and
   transmitting means for transmitting a frame composed of said slots spread by uniform transmission power in response to said judging result.

4. The CDMA communication apparatus according to claim 3, wherein said spread controlling means(1101) spreads transmission controlling information to the entirety of slot in a case where no transmission data is given.

5. The CDMA communication apparatus according to claim 3, wherein said transmitting means transmits transmission controlling information and transmission data by the first slot in compliance with the result of judgement by said rate judgement means in a case where the transmission data rate is low and controls so as to cut off the transmission immediately after said transmission data is transmitted.

6. The CDMA communication apparatus according to claim 3, further comprising;

   rate change judging means for judging whether or not a transmission data rate is changed; and transmission controlling means which, if the rate is not changed, transmits transmission controlling information of the first slot of a next frame by the same transmission power as that of the frame being transmitted, and which if the rate is changed, transmits transmission control information of the next first slot by the same transmission power as that on the commencement of transmission, in compliance with the result of judgement.

7. The CDMA communication apparatus according to claim 6, wherein said transmission controlling means transmits, at random, transmission controlling information of the first slot of transmission frame in a case where transmission is continuously carried out by the same transmission power.

8. The CDMA communication apparatus according to claim 1, wherein said transmission controlling information includes a pilot symbol and a power controlling signal.

9. The CDMA communication apparatus according to claim 1, wherein, in compliance with the result of judgement, if no transmission data is given, transmission controlling information of the first slot and specified pattern data thereof are transmitted by the same transmission power, and if the transmission data rate is low, the transmission data is repeatedly transmitted while transmitting the transmission controlling information and transmission data.

10. A CDMA communication apparatus comprising:

    multiplexing means(1103) for constituting a frame by multiplexing transmission controlling information and transmission data;
    spread means for spreading the transmission

controlling information and transmission data by different codes; and

transmission means for transmitting said processed frame.

11. The CDMA communication apparatus according to claim 1, wherein said multiplexing means(1103) constitutes transmission controlling information by patterns constituted with different phases.

12. The CDMA communication apparatus according to claim 10, further comprising;

transmission power controlling means for controlling transmission power of transmission controlling information in response to a transmission rate.

13. The CDMA communication apparatus according to claim 10, wherein said multiplexing means(1103) gives transmission controlling information to the top slot of transmission data.

14. A mobile station having a communication apparatus, said apparatus comprising;

rate judging means for judging a transmission data rate in the first slot of a transmission frame;

level controlling means(1113,1114) for carrying out a process by which the transmission power of transmission controlling information given to the top of each slot in slots including and after the second slot is made identical to a transmission power of transmission data; and

transmitting means for transmitting said frame processed by uniform transmission power in response to said rate judging means.

15. A base station having a communication apparatus, said apparatus comprising;

rate judging means for judging a transmission data rate in the first slot of a transmission frame;

level controlling means(1113,1114) for carrying out a process by which the transmission power of transmission controlling information given to the top of each slot in slots including and after the second slot is made identical to a transmission power of transmission data; and

transmitting means for transmitting said frame processed by uniform transmission power in response to said rate judging means.

16. A CDMA communication system comprising:

a mobile station having a CDMA communication apparatus according to claim 14; and

a base station having a CDMA communication apparatus according to claim 15.

17. A CDMA communication method comprising the steps of:

judging a rate of transmission data by the first slot of transmission frame; and

transmitting transmission controlling information and transmission data, which are transmitted by slots including and after the second slot, by uniform transmission power in response to the result of said judgement.

18. The CDMA communication method according to claim 17, wherein, in compliance with the result of judgement, if no transmission data is given, only the transmission controlling information is transmitted, transmission controlling information to be transmitted by slots including and after the second slot is transmitted by smaller transmission power than the transmission power of the first slot, and a dummy signal is transmitted by the same transmission power as said transmission power.

19. The CDMA communication method according to claim 17, wherein, in compliance with the result of judgement, if the transmission data rate is low, transmission controlling information and transmission data are transmitted by the first slot, and they are transmitted by slots including and after the second slot so that the sum of symbol lengths of the transmission controlling information and transmission data is made equal to a slot length.

20. The CDMA communication method according to claim 17, wherein, in compliance with the result of judgement, if the transmission data rate is low, transmission controlling information and transmission data are transmitted by the same transmission power by the first slot, and the transmission is brought to an end immediately after the transmission of said transmission data is finished.

21. The CDMA communication method according to claim 17, wherein, in compliance with the result of judgement, if no transmission data is given, only the transmission controlling information is transmitted by the first slot, and transmission controlling information to be transmitted by slots including and after the second slot are spread to the entirety of slot for transmission.

22. The CDMA communication method according to claim 17, wherein, in compliance with the result of judgement, if the transmission data rate is low, transmission controlling information and transmis-

sion data are transmitted by the first slot, and transmission controlling information and transmission data are spread to the entirety of slot in slots including and after the second slot for transmission.

23. The CDMA communication method according to claim 17, wherein, in compliance with the result of judgement, if no transmission data is given, transmission controlling information and specified pattern data are transmitted by the first slot by the same transmission power.

24. The CDMA communication method according to claim 17, wherein, in compliance with the result of judgement, if the transmission data rate is low, transmission controlling information and specified pattern data are transmitted by the first slot, and the same transmission data is repeatedly transmitted.

25. The CDMA communication method according to claim 17, wherein it is judged whether or not the transmission data rate is changed, if not changed, transmission controlling information of the first slot of a next frame is transmitted by the same transmission power as that of the frame being transmitted, and if changed, transmission controlling information of the next first slot is transmitted by the same transmission power as that on the commencement of transmission.

26. The CDMA communication method according to claim 25, wherein in a case where transmission is continuously carried out by the same transmission power, transmission controlling information of the first slot of transmission frame is transmitted, at random, by the same transmission power as that on the commencement of transmission.

27. The CDMA communication method according to claim 17, wherein said transmission controlling information includes a pilot symbol and a power controlling signal.

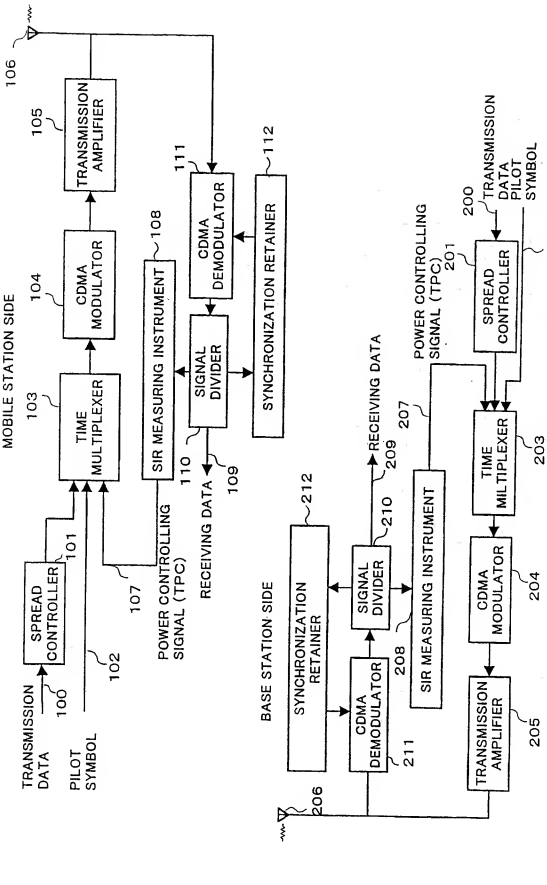
28. A CDMA communication method comprising the steps of:

constituting a frame by multiplexing transmission controlling information and transmission data;
spreading transmission controlling information and transmission data by different codes; and
transmitting said processed frame.

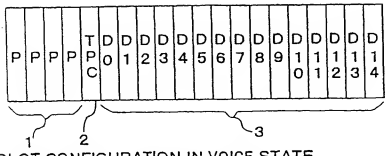
29. The CDMA communication method according to claim 28, wherein transmission controlling information is constituted by patterns constituted with different phases.

30. The CDMA communication method according to claim 28, wherein the transmission power of transmission controlling information is controlled in response to transmission rate.

31. The CDMA communication method according to claim 28, wherein transmission controlling information is given to the top slot of transmission data.

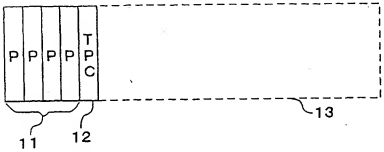


PROIOR ART FIG. 1



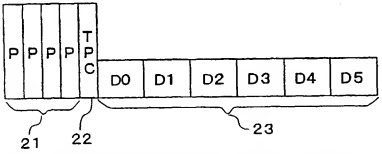
SLOT CONFIGURATION IN VOICE STATE

FIG. 2A



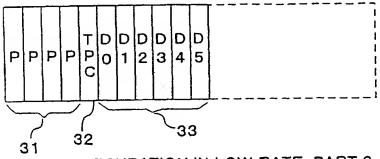
SLOT CONFIGURATION IN SILENT STATE

FIG. 2B



SLOT CONFIGURATION IN LOW RATE, PART 1

FIG. 2C



SLOT CONFIGURATION IN LOW RATE, PART 2

FIG. 2D

VOICE STATE

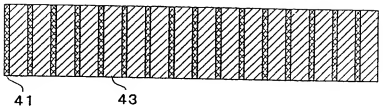


FIG. 3A

SILENT STATE

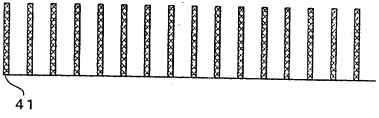


FIG. 3B

LOW RATE (1)

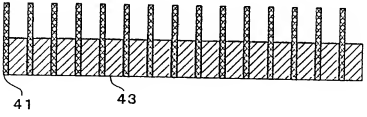


FIG. 3C

LOW RATE (2)

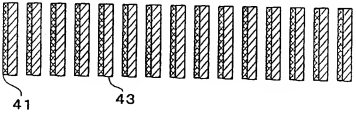


FIG. 3D

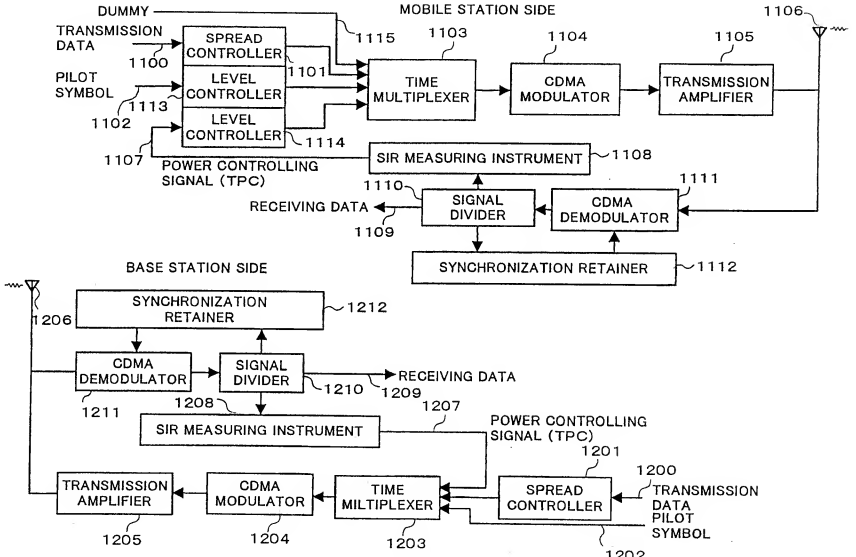


FIG. 4

EP 0 893 889 A2

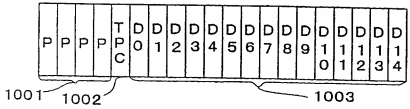


FIG. 5A

FIRST SLOT WHEN VOICE IS GIVEN

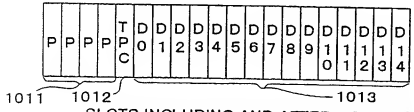


FIG. 5B

SLOTS INCLUDING AND AFTER SECOND SLOT WHEN VOICE IS GIVEN

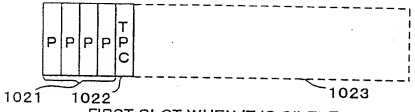


FIG. 5C

FIRST SLOT WHEN IT IS SILENT

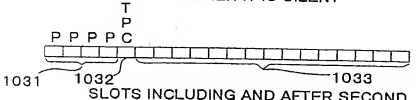


FIG. 5D

SLOTS INCLUDING AND AFTER SECOND SLOT WHEN IT IS SILENT

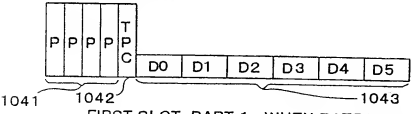


FIG. 5E

FIRST SLOT, PART 1, WHEN RATE IS LOW

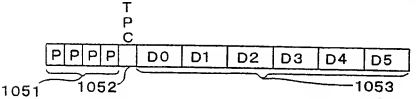


FIG. 5G

SLOTS INCLUDING AND AFTER SECOND SLOT WHEN RATE IS LOW

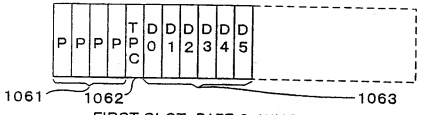


FIG. 5F

FIRST SLOT, PART 2, WHEN RATE IS LOW

WHEN VOICE IS GIVEN

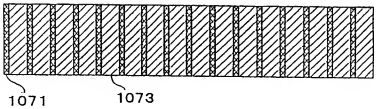


FIG. 6A

WHEN IT IS SILENT

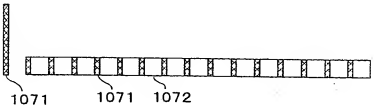


FIG. 6B

WHEN RATE IS LOW

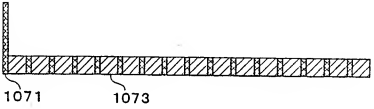


FIG. 6C

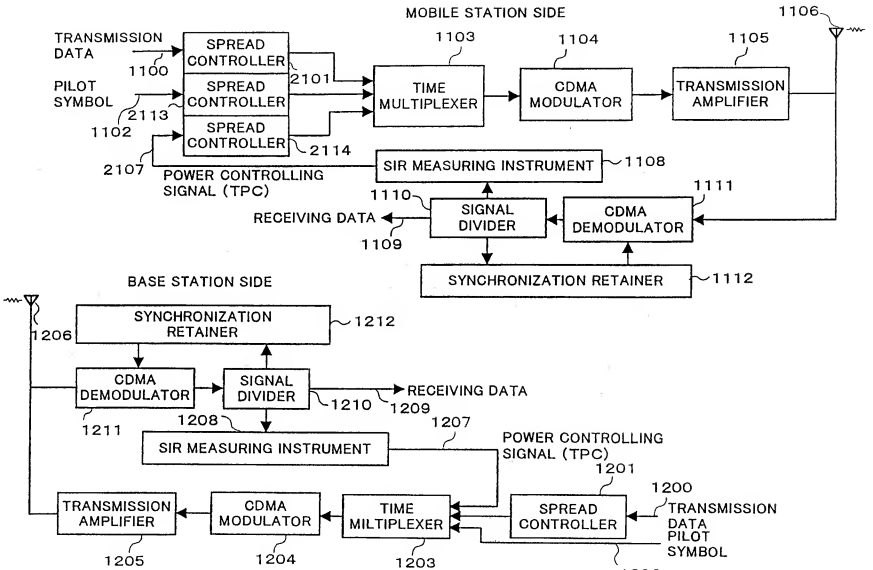


FIG. 7

EP 0 893 889 A2

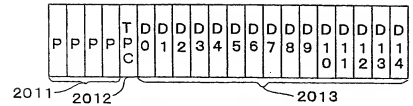


FIG. 8A

FIRST SLOT WHEN VOICE IS GIVEN

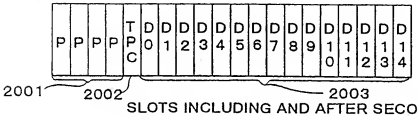


FIG. 8B

SLOTS INCLUDING AND AFTER SECOND SLOT WHEN VOICE IS GIVEN

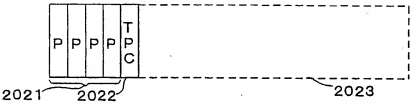


FIG. 8C

FIRST SLOT WHEN IT IS SILENT

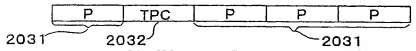


FIG. 8D

SLOTS INCLUDING AND AFTER SECOND SLOT WHEN IT IS SILENT

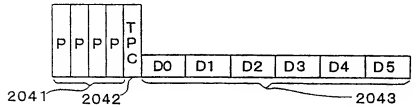


FIG. 8E

FIRST SLOT, PART 1, WHEN RATE IS LOW

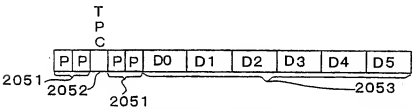


FIG. 8G

SLOTS INCLUDING AND AFTER SECOND SLOT WHEN RATE IS LOW

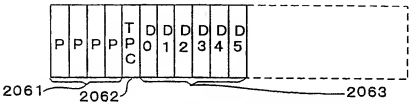


FIG. 8F

FIRST SLOT, PART 2, WHEN RATE IS LOW

WHEN VOICE IS GIVEN

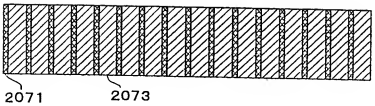


FIG. 9A

WHEN IT IS SILENT

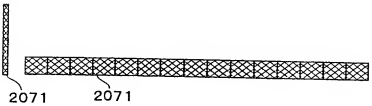


FIG. 9B

WHEN RATE IS LOW

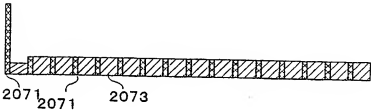


FIG. 9C

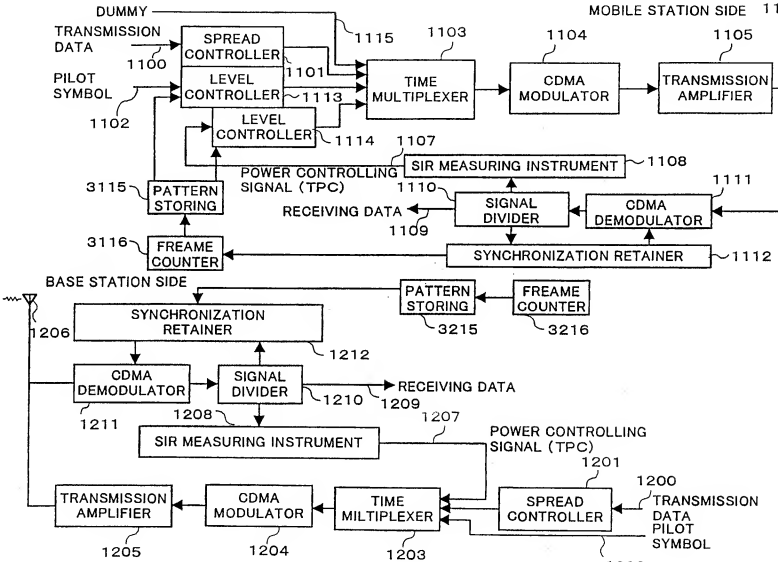
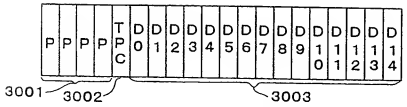


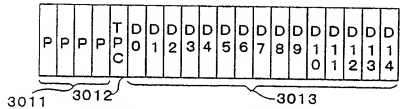
FIG. 10

EP 0 893 889 A2



FIRST SLOT WHEN VOICE IS GIVEN

FIG. 11A

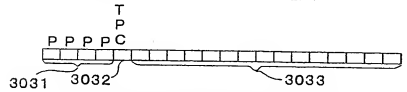


SLOTS INCLUDING AND AFTER SECOND SLOT WHEN VOICE IS GIVEN

FIG. 11B

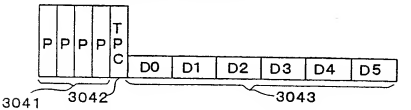
FIRST SLOT WHEN IT IS SILENT

FIG. 11C



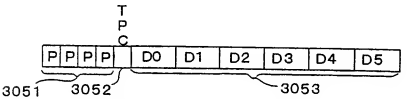
SLOTS INCLUDING AND AFTER SECOND SLOT WHEN IT IS SILENT

FIG. 11D



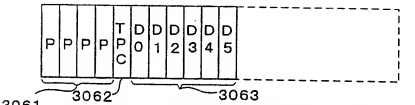
FIRST SLOT, PART 1, WHEN RATE IS LOW

FIG. 11E



SLOTS INCLUDING AND AFTER SECOND SLOT WHEN RATE IS LOW

FIG. 11G



FIRST SLOT, PART 2, WHEN RATE IS LOW

FIG. 11F

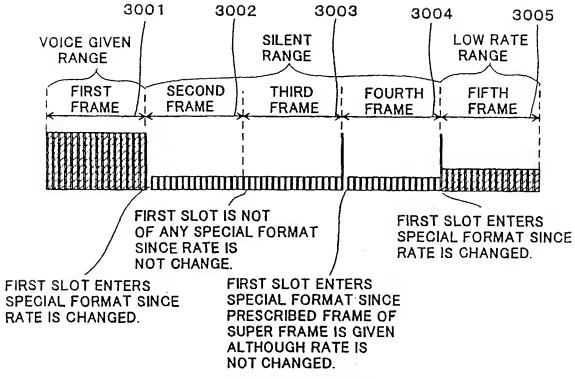
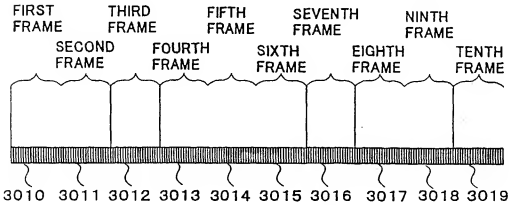


FIG. 12A



EXAMPLE WHERE SILENT STATE IS COUTINUED

FIG. 12B

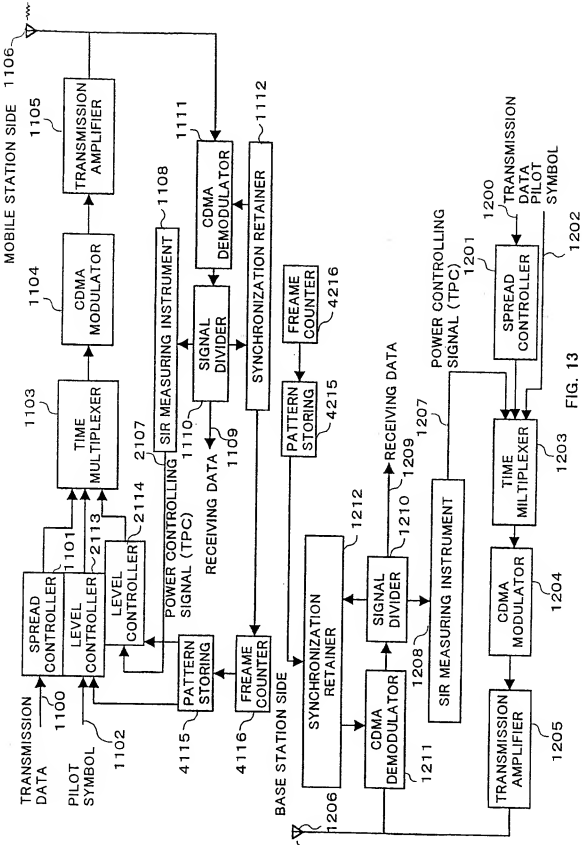
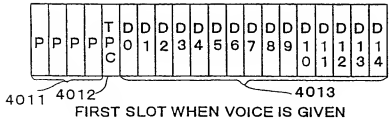
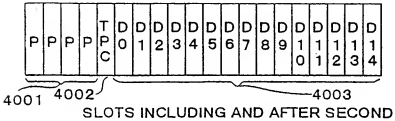

MOBILE STATION SIDE
1106
1105
TRANSMISSION AMPLIFIER
1104
CDMA MODULATOR
1103
TIME MULTIPLEXER
1101
LEVEL CONTROLLER
2113
LEVEL CONTROLLER
2114
2107
SIR MEASURING INSTRUMENT
1108
1111
CDMA DEMODULATOR
1110
SIGNAL DIVIDER
1109
RECEIVING DATA
1112
SYNCHRONIZATION RETAINER
FREAME COUNTER
4216
PATTERN STORING
4215
POWER CONTROLLING SIGNAL (TPC)
1102
1100
SPREAD CONTROLLER
TRANSMISSION DATA
PILOT SYMBOL
4115
PATTERN STORING
4116
FREAME COUNTER
BASE STATION SIDE
1206
SYNCHRONIZATION RETAINER
1212
CDMA DEMODULATOR
1211
SIGNAL DIVIDER
1210
1208
1209
RECEIVING DATA
1207
POWER CONTROLLING SIGNAL (TPC)
1201
SIR MEASURING INSTRUMENT
TRANSMISSION AMPLIFIER
1205
CDMA MODULATOR
1204
TIME MILTIPLEXER
1203
SPREAD CONTROLLER
1200
TRANSMISSION DATA
PILOT SYMBOL
1202

FIG. 13



FIRST SLOT WHEN VOICE IS GIVEN

FIG. 14A

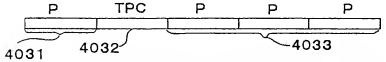


SLOTS INCLUDING AND AFTER SECOND SLOT WHEN VOICE IS GIVEN

FIG. 14B

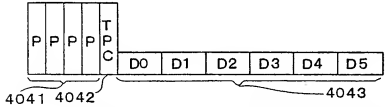
FIRST SLOT WHEN IT IS SILENT

FIG. 14C



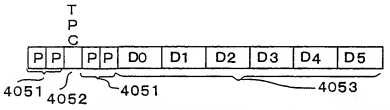
SLOTS INCLUDING AND AFTER SECOND SLOT WHEN IT IS SILENT

FIG. 14D



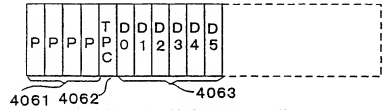
FIRST SLOT, PART 1, WHEN RATE IS LOW

FIG. 14E



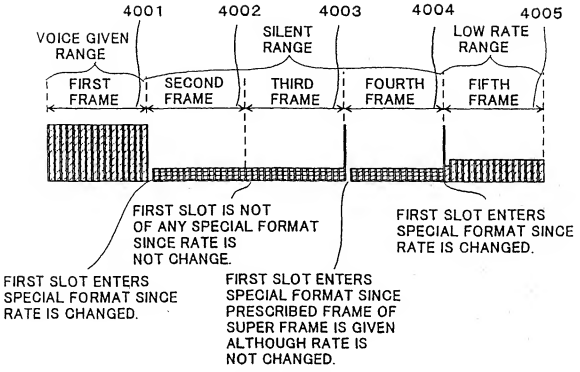
SLOTS INCLUDING AND AFTER SECOND SLOT WHEN RATE IS LOW

FIG. 14G



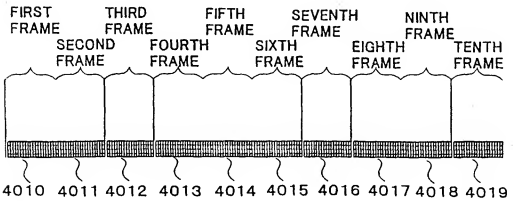
FIRST SLOT, PART 2, WHEN RATE IS LOW

FIG. 14F



EXAMPLES WHERE VOICE OR SILENT STATE OR LOW RATE ARISES.

FIG. 15A



EXAMPLE WHERE SILENT STATE IS COUTINUED

FIG. 15B

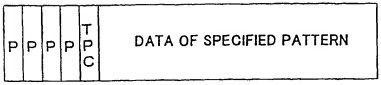


FIG. 16A

FIRST SLOT IN SILENT STATE

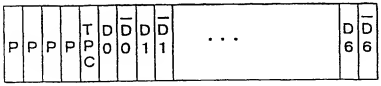


FIG. 16B

FIRST SLOT IN LOW RATE
DO AND $\overline{DO}$ SHOWS INVERSAL.

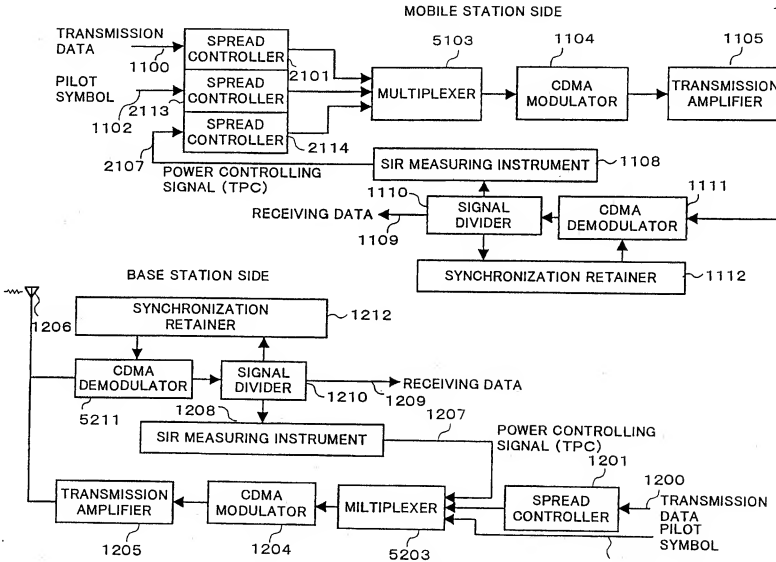

MOBILE STATION SIDE
TRANSMISSION DATA
1100
PILOT SYMBOL
2113
1102
SPREAD CONTROLLER
SPREAD CONTROLLER
SPREAD CONTROLLER
2101
2114
2107
POWER CONTROLLING SIGNAL (TPC)
5103
MULTIPLEXER
1104
CDMA MODULATOR
1105
TRANSMISSION AMPLIFIER
1106
SIR MEASURING INSTRUMENT
1108
1110
RECEIVING DATA
1109
SIGNAL DIVIDER
CDMA DEMODULATOR
1111
SYNCHRONIZATION RETAINER
1112
BASE STATION SIDE
1206
SYNCHRONIZATION RETAINER
1212
CDMA DEMODULATOR
5211
SIGNAL DIVIDER
1210
RECEIVING DATA
1209
1208
SIR MEASURING INSTRUMENT
1207
POWER CONTROLLING SIGNAL (TPC)
1201
TRANSMISSION AMPLIFIER
1205
CDMA MODULATOR
1204
MILTIPLEXER
5203
SPREAD CONTROLLER
1200
TRANSMISSION DATA
PILOT SYMBOL
1202

FIG. 17

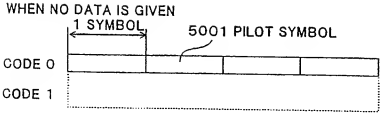


FIG.18A

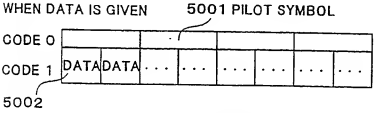


FIG.18B

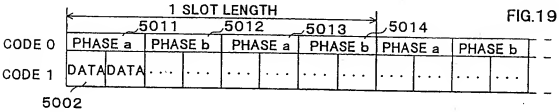


FIG.19

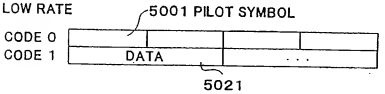


FIG. 20A

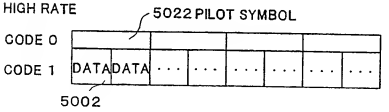


FIG. 20B

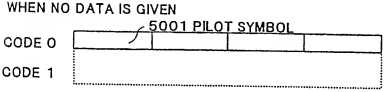


FIG. 21A

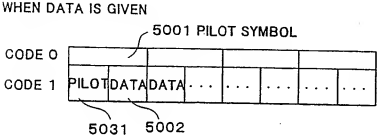


FIG. 21B

(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 893 889 A3

(12) EUROPEAN PATENT APPLICATION

(88) Date of publication A3:
24.02.1999 Bulletin 1999/08

(43) Date of publication A2:
27.01.1999 Bulletin 1999/04

(51) Int. Cl.[6]: **H04B 7/005**, H04B 1/707

(21) Application number: **98107736.5**

(22) Date of filing: **28.04.1998**

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Designated Extension States:
AL LT LV MK RO SI

(30) Priority: **19.07.1997 JP 209638/97**

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(54) Method and apparatus for transmission power control in a CDMA communication system

(57) Pilot symbol 1021 of the first slot and TPC symbol 1022 thereof are transmitted by the same transmission power as that one the commencement of transmission, and the transmission power of data symbol 1023 is made zero. In slots including and after the second slot, pilot symbol 1031 and TPC symbol 1032 are transmitted at the same position as that on the commencement of transmission and by smaller transmission power than that on the commencement of transmission, and further dummy signal 1033 is transmitted, as in the above, by the same transmission power after TPC.

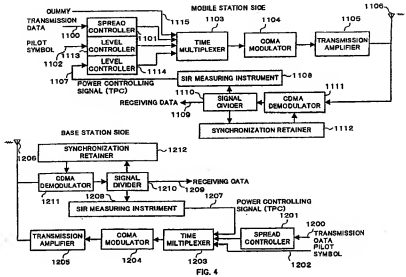

FIG. 4

EP 0 893 889 A3

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 98 10 7736

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
A	WO 92 16059 A (TELENOKIA OY) 17 September 1992 * abstract * * page 1, line 4 - line 10 * * page 2, line 18 - line 33 * * page 3, line 23 - line 35 * * claim 1; figure 1 *	1,3,10, 14-17,28	H04B7/005 H04B1/707
A	US 5 528 593 A (ENGLISH SEAN ET AL) 18 June 1996 * abstract * * column 5, line 38 - line 45 * * claim 1; figures 2,3 *	1,3,10, 14-17,28	
A	WO 97 00562 A (QUALCOMM INC) 3 January 1997 * page 5, line 25 - page 6, line 18 * * page 17, line 37 - page 18, line 7 * * page 18, line 36 - page 19, line 17 * * claims 1,7-9; figures 4,5 *	1,3,10, 14-17,28	
			TECHNICAL FIELDS SEARCHED (Int.Cl.6) H04B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	6 January 1999	López Márquez, T

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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A : technological background
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P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

APPENDIX E

Hogan (US Patent Pub. 2001/0018741), cited by the Examiner in the Final Office Action dated April 20, 2007.

US 20010018741A1

(19) United States

(12) Patent Application Publication (10) Pub. No.: US 2001/0018741 A1

Hogan (43) Pub. Date: Aug. 30, 2001

(54) METHOD AND APPARATUS FOR PERFORMING DATA ENCRYPTION AND ERROR CODE CORRECTION

(76) Inventor: Josh N. Hogan, Los Altos, CA (US)

Correspondence Address:
HEWLETT-PACKARD COMPANY
Intellectual Property Administration
P.O. Box 272400
Fort Collins, CO 80527-2400 (US)

(21) Appl. No.: 09/783,112

(22) Filed: Feb. 14, 2001

Related U.S. Application Data

(63) Continuation of application No. 09/053,972, filed on Apr. 2, 1998, now Pat. No. 6,252,961, which is a continuation-in-part of application No. 08/896,002, filed on Jul. 17, 1997, now Pat. No. 6,047,069.

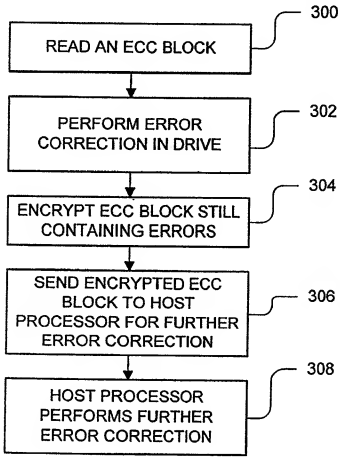
Publication Classification

(51) Int. Cl.[7] H04L 9/32; G06F 11/30; G06F 12/14

(52) U.S. Cl. 713/189

(57) ABSTRACT

A drive such as a DVD-ROM drive encrypts an error code correction (ECC) block in a manner that still retains the error correction capabilities of the ECC block. Encryption is performed by generating an encryption mask including a plurality of random numbers and redundancy data. The encryption mask is bitwise XOR'ed with the ECC block. The product of the bitwise XOR is an encrypted ECC block, which can then be transmitted over an unsecured bus to a host processor. The integrity of the ECC codewords is preserved. This allows the host processor to perform some or all error correction on the encrypted ECC block. Error correction can be removed from the drive altogether, or error correction can be performed by the drive and additionally by the host processor, if necessary. User data in the ECC block can be XOR'ed entirely with random numbers, or the user data can be XOR'ed selectively with random numbers and zeros to selectively encrypt a portion of the user data. Portions of the ECC block XOR'ed with zeros or not XOR'ed at all are not encrypted. If the encrypted data is not required downstream, it is left unencrypted or it is discarded. If the encrypted data is required downstream by an entity such as a trusted decoder, information needed to decrypt the data is transmitted in a secure manner to that entity.



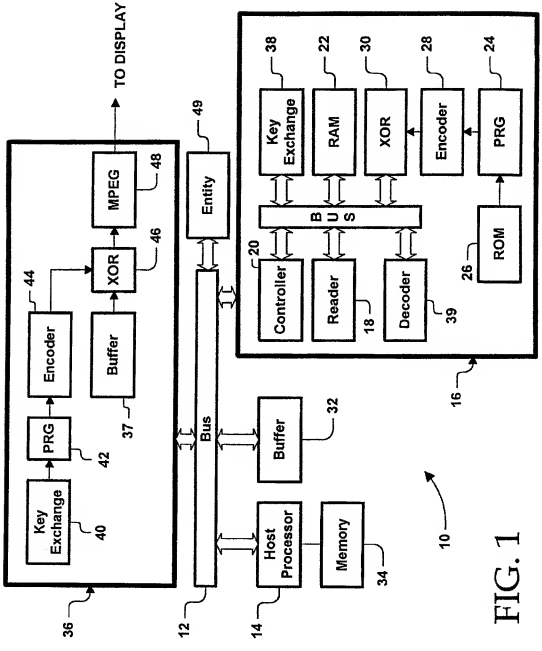

TO DISPLAY
MPEG
48
XOR
46
Buffer
37
Encoder
44
PRG
42
Key Exchange
40
36
Entity
49
Bus
12
Buffer
32
Host Processor
14
Memory
34
10
16
Key Exchange
38
RAM
22
XOR
30
Encoder
28
PRG
24
BUS
Controller
20
Reader
18
Decoder
39
ROM
26

FIG. 1

FIG. 2

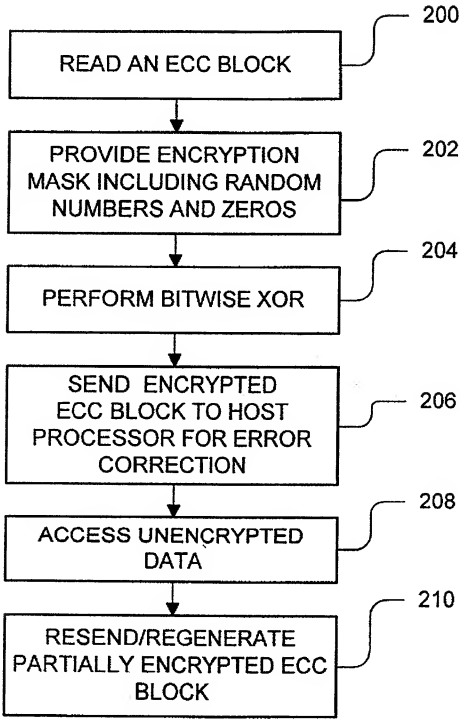
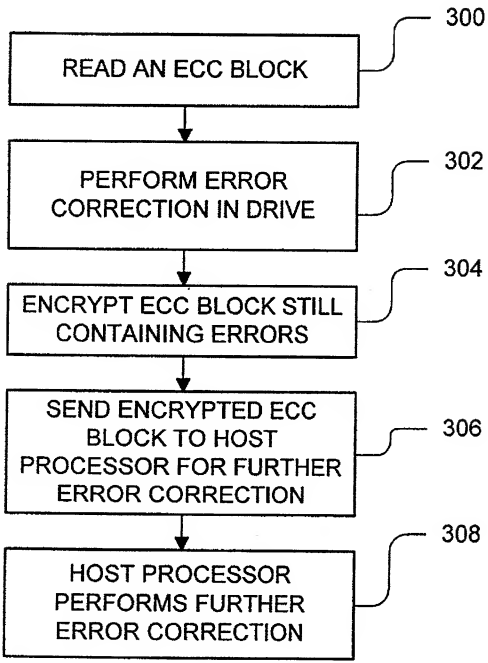

200
READ AN ECC BLOCK
202
PROVIDE ENCRYPTION MASK INCLUDING RANDOM NUMBERS AND ZEROS
204
PERFORM BITWISE XOR
206
SEND ENCRYPTED ECC BLOCK TO HOST PROCESSOR FOR ERROR CORRECTION
208
ACCESS UNENCRYPTED DATA
210
RESEND/REGENERATE PARTIALLY ENCRYPTED ECC BLOCK

FIG. 3


300
READ AN ECC BLOCK
302
PERFORM ERROR CORRECTION IN DRIVE
304
ENCRYPT ECC BLOCK STILL CONTAINING ERRORS
306
SEND ENCRYPTED ECC BLOCK TO HOST PROCESSOR FOR FURTHER ERROR CORRECTION
308
HOST PROCESSOR PERFORMS FURTHER ERROR CORRECTION

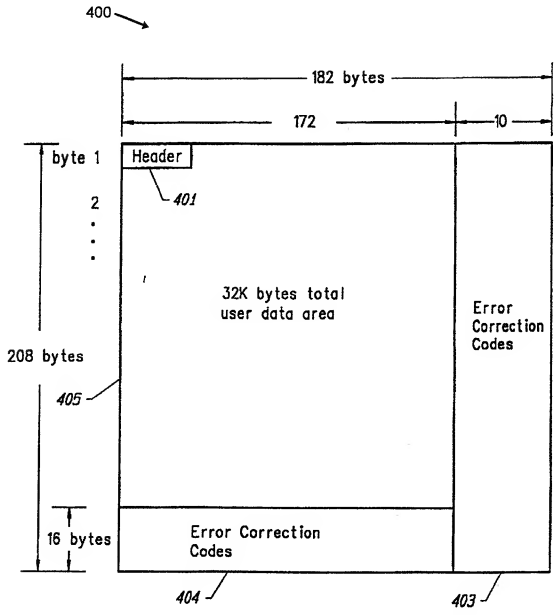


FIG. 4
(PRIOR ART)

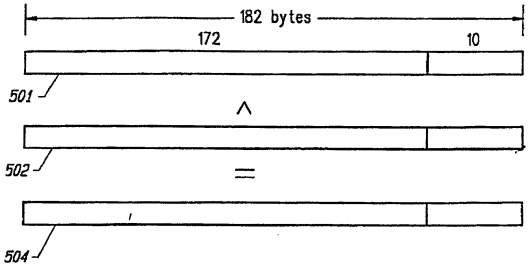


FIG. 5

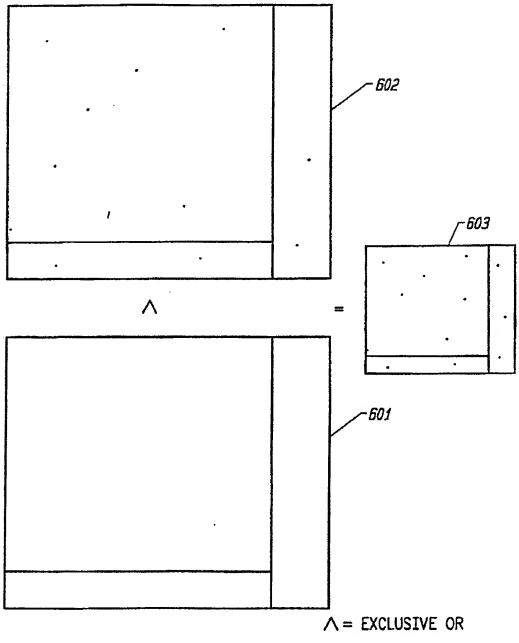


FIG. 6

METHOD AND APPARATUS FOR PERFORMING DATA ENCRYPTION AND ERROR CODE CORRECTION

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This is a continuation-in-part of Ser. No. 08/896,002 filed Jul. 15, 1997, now.

BACKGROUND OF THE INVENTION

[0002] The invention relates generally to data storage and transmission. More particularly, the invention relates to the encryption of data that includes codewords used for forward error correction.

[0003] Forward error correction is commonly performed in data transmission channels and data storage devices in order to maintain the integrity of user data. Redundancy data is added to the user data prior to transmission or storage. In data storage devices such as hard disk drives, compact disk (CD) players and Digital Video Disk (DVD) players, errors can occur due to defects in the storage medium and noise in the read channels. If an error is detected in the transmitted or stored data, the redundancy data allows the error to be corrected.

[0004] There are various methods of performing forward error correction. For instance, Reed-Solomon Product Code ("RS-PC") is used in CD and DVD players.

[0005] The CD and DVD players include error correction circuits for performing the forward error correction. The error correction circuits are computationally intensive and are typically implemented in a hardwired or inflexible manner. Additionally, the error correction circuits tend to be expensive in processing circuitry and high-speed memory.

[0006] Recent increases in processing power of personal computers will make it practical to perform full or partial forward error correction in the computer's host processor instead of the data storage device. Allowing the host processor to perform error correction would allow for more flexible error correction methods to be utilized. For example, the host processor could execute a default routine that is fast and that could correct a large majority of errors. Errors that could not be corrected by the default routine would be corrected by a more complex routine, such as a "heroic data recovery" routine. Heroic recovery is especially valuable in connection with long term storage of data. Hardcopies of valuable data might be destroyed following storage on a storage medium (e.g., a platter of a hard drive or a CD). In the months and years following the storage, long-term degradation of the storage medium might occur. A typical error correction circuit in a storage device might not be able to recover all of the data from the degraded storage medium. If such data cannot be recovered, it might be lost forever. The host processor, however, is more likely to recover the data using heroic data recovery routines.

[0007] The task of performing error correction could be shifted entirely or partially to the host processor. Consequently, the cost of the storage device could be reduced. The decoder circuit could be reduced or eliminated and expensive static random access memory (RAM) could be reduced in size.

[0008] In the alternative, the task of performing error correction could be divided between the host processor and the error correction circuit in the storage device. The task of correcting errors would fall initially on the error correction circuit, which would utilize a simple error correction algorithm that identifies and corrects the majority of errors. In the event the error correction circuit could not correct a data block, the task would be shifted to the host processor, which would use a more complex error correction routine. Such flexibility would allow for a fast, inexpensive error correction circuit to be used by the storage device. Consequently, the cost of the storage device would be lowered and the reliability of performing error correction would be improved.

[0009] However, there can be problems associated with performing the error correction in the host processor, especially after data encryption has been performed on data including error code correction ("ECC") codewords. If the ECC codewords are encrypted, the integrity of the codewords is typically destroyed. Consequently, errors in the data cannot be corrected by the host processor.

[0010] Yet there is an increasing pressure in the industry to encrypt the data before the data is sent from the storage device to the host processor. This is especially true for DVD-ROM drives on computers. Data is sent from a DVD-ROM drive to a DVD decoder card over a computer bus, which is not secure. There is a genuine concern that unencrypted data placed on the bus could be intercepted, and unauthorized copies of high quality movies, music, and proprietary data could be made. If unencrypted data were sent to the host processor for error correction, it would be vulnerable to theft and unauthorized copying. Therefore, the data is not error code corrected in the host processor. Instead, error code correction is performed on the data in the DVD-ROM drive. The error code corrected data is then encrypted before being sent to the DVD decoder card via the unsecured computer bus.

[0011] Thus far, the host processor has been precluded from performing error correction due to the need for secure transmissions over the computer bus. Consequently, the cost of the DVD-ROM drive has not been reduced by eliminating the expensive decoder and reducing expensive RAM for performing error correction. Additionally, the flexibility of performing different error correction routines has not been available.

SUMMARY OF THE INVENTION

[0012] The present invention allows partial or full data encryption to be performed in the drive and partial or full error correction to be performed by the host processor. A block of ECC-encoded data is read. The ECC block includes error correction codewords. An encryption mask is provided and bitwise XOR'ed with the ECC block. The product of the bitwise XOR is an encrypted ECC block, which can then be transmitted to the host processor. The integrity of the codewords is preserved. This allows the host processor to perform some or all error correction on encrypted ECC block.

[0013] User data in the ECC block can be XOR'ed entirely with numbers in the encryption mask, or the user data can be XOR'ed selectively with numbers in the encryption mask. Portions of the ECC block XOR'ed with zeros or not XOR'ed at all are not encrypted.

[0014] Other aspects and advantages of the present invention will become apparent from the following detailed description, taken in conjunction with the accompanying drawings, illustrating by way of example the principles of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] **FIG. 1** is a block schematic diagram of various components of a computer system according to the present invention;

[0016] **FIG. 2** is flowchart of a method of performing error code correction and data encryption according to the invention;

[0017] **FIG. 3** is a flowchart of an alternative method of performing error code correction and data encryption according to the invention;

[0018] **FIG. 4** illustrates a simplified layout of an RS-PC block;

[0019] **FIG. 5** illustrates a bitwise XOR operation performed by the computer system; and

[0020] **FIG. 6** is a block diagram showing an RS-PC block, an encryption mask, and a product of a bitwise XOR of the RS-PC block and the encryption mask.

DETAILED DESCRIPTION OF THE INVENTION

[0021] As shown in the drawings for purposes of illustration, the invention is embodied in a system including a host processor and a storage device that reads data from a storage medium (e.g., a compact disc or DVD disc). The data includes ECC codewords. The storage device performs data encryption on the data read from the storage medium, but preserves the integrity of error correction codewords. This allows the encrypted data to be transmitted to the host processor over an unsecure computer bus. The host processor can then perform error correction on the encrypted data. Afterwards, decryption can be performed by a trusted entity. Thus, the invention allows partial or full error correction of ECC codewords to be performed by a host computer without the danger of exposing confidential data on an unsecured computer bus.

[0022] In the paragraphs that follow, the invention will be described in connection with a computer system including a DVD-ROM drive and associated DVD-ROM electronics. It is understood that the invention is not limited to a DVD-ROM drive, and that the DVD-ROM is mentioned merely to facilitate an understanding of the invention.

[0023] **FIG. 1** shows various components of a computer system **10**. The computer system **10** includes a computer bus **12** and a host processor **14** (e.g., a central processing unit) connected to the computer bus **12**. The system **10** further includes a DVD-ROM drive **16** including a DVD-ROM reader **18** that is operable to read RS-PC blocks stored on a DVD-ROM disc. RS-PC blocks are read from the DVD disc and, under control of a controller **20**, buffered in random access memory (RAM) **22**.

[0024] Each RS-PC block includes M rows of user data, with each word of user data being N-bytes long. Appended to each of the M words is RS-PC redundancy data having a length of p-bytes. Thus, each row in the RS-PC block has (N+p) bytes, whereby the RS-PC block has (N+p) columns. Appended to each of the (N+p) columns is RS-PC redundancy data having a length of q-bytes. Resulting is an RS-PC block having (M+q)×(N+p) bytes. Such an RS-PC block **602** is shown in **FIG. 6**.

[0025] The DVD-ROM drive **16** does not need to perform error-code correction on the buffered RS-PC blocks. Instead, the DVD-ROM drive **16** performs encryption on the buffered RS-PC blocks. A first pseudorandom generator **24** generates an M×N block of random numbers, each number having a length of one byte. The random numbers may, for example, be generated from a seed that is accessed from a ROM module **26**.

[0026] The M×N block of random numbers is supplied to an RS-PC encoder **28**, which performs RS-PC encoding on the M×N block. An output of the encoder **28** provides an encryption mask having (M+q)×(N+p) bytes. The encoder **28**, which includes a plurality of linear feedback shift registers, is relatively simple and inexpensive to implement. Additionally, the RS-PC encoding can be performed relatively quickly. The encoder **28** uses the same algorithm that was used for generating the codewords stored on the DVD disc.

[0027] An XOR circuit **30** performs a bitwise exclusive OR (XOR) of the RS-PC block and the encryption mask. A bitwise XOR operation is illustrated in **FIG. 3** and discussed below. Resulting from the bitwise XOR is an (M+q)×(N+p) encrypted block including encrypted user data and encrypted RS-PC redundancy data.

[0028] Under the control of the controller **20**, the encrypted block is placed on the computer bus **12** and stored in a buffer **32** for error correction. Even though the computer bus **12** is unsecured, the user data in the encryption block is encrypted and, therefore, protected. Thus, the user data is not made readily available to bus sniffer devices such as storage scopes and data analyzers that could analyze data transferred across the computer bus **12**.

[0029] The host processor **14** is instructed to perform error correction by executable instructions store in memory **34**. While the instructions are being executed by the host processor **14**, the host processor **14** performs RS-PC correction on the encrypted data block stored in the buffer **32**.

[0030] The host processor **14** sends the still encrypted, but now error-corrected, (M+q)×(N+p) block to a DVD decoder card **36** via the computer bus **12**. The encrypted block is received and stored in a buffer **37** on the DVD decoder card **36**. If the DVD decoder card **36** performs decryption on the encrypted block, it accesses the seed stored in the ROM **26**, that is, the seed from which the encryption mask was generated. Modules **38** and **40** perform authentication and exchange of the seed between the DVD-ROM drive **16** and the DVD decoder card **36**. Authentication and exchange can be performed in a conventional manner.

[0031] A second pseudorandom generator **42** on the DVD decoder card **36** generates the same sequence of random numbers generated by the first pseudorandom generator **24**, and a second encoder **44** generates an M×N decryption mask from the random numbers. The decryption mask is identical to the M×N block of random numbers in the encryption mask. Thus, the decryption mask is generated by sending a

minimum amount of data (i.e., the seed) via the authentication and exchange modules **38** and **40**.

[0032] A second XOR circuit **46** then performs a bitwise XOR of the decryption mask and the M×N user data in the encrypted block stored in the buffer **37**. The product of the bitwise XOR is an unencrypted M×N block of user data.

[0033] The DVD decoder card **36** also includes a Moving Pictures Experts Group (MPEG) decoder **48** which receives the RS-PC block and decodes the M×N byte block of decrypted user data according to an MPEG standard. The MPEG decoder **48** outputs a stream of uncompressed data, which is displayed on a video display. The uncompressed data is sent directly to the display or display memory. The uncompressed data is not transmitted on the computer bus **12**.

[0034] The error-corrected encrypted block can be received by other entities **49** downstream the host processor **14**. A downstream entity **49** could regenerate the encrypted block for subsequent data transmission. Encrypted data that is not accessed by the downstream entity **49** can be discarded by the downstream entity **49**. If a downstream entity **49** is not allowed access to the data in the encrypted block, the seed is not sent to that downstream entity **49**.

[0035] The drive **16** might also have basic error correction capability. For example, the drive could include a decoder **39** for performing on-the-fly error correction. If the decoder **39** cannot correct a data block, the data block is sent to the host processor **14**. Such flexibility would allow a fast, inexpensive decoder **39** to be used for error correction. Such flexibility would also allow for more complex, more accurate error correction to be performed by the host processor **14**.

[0036] FIGS. **4** to **6** show the bitwise XOR operation in greater detail **FIG. 4** shows a simplified version of an RS-PC block **400**. The M×N block **405** of user data is **32K** bytes. RS-PC redundancy data **403, 404** is associated with each row and each column in the block **400**. The length of the RS-PC block **400** is 182 bytes, of which 172 bytes are user data **405**. The remaining ten bytes are RS-PC redundancy data **403** that are added for error recovery. The number of rows in the RS-PC block **400** is 208 with sixteen rows including RS-PC redundancy data **404**. A header **401** contains information relating to copy protection, in particular, an encryption key. Under normal circumstances the user receives this data and never needs to know the contents of the header **401** or the RS-PC redundancy data **403** and **404**. That information is extracted and checked while the data is in the drive. The M×N block **405** of user data might also include a lead-in area (not shown) that contains highly confidential data.

[0037] Referring to **FIG. 5**, a row **501** of an RS-PC block includes 172 bytes of user data and tens bytes of RS-PC redundancy data that is created from the user data in the row **501**. A row **502** of an encryption mask includes 172 bytes of random numbers and ten bytes of RS-PC redundancy data that is created from the 172 bytes of random numbers in the row **502**. When the two rows **501** and **502** are bitwise XOR-ed together, a row **504** of an encrypted block is formed. The row **504** of the encrypted block includes 172 bytes of encrypted data and ten bytes of redundancy data, which provides a valid RS-PC codeword for the 172 bytes of encrypted data in the row **504**. Decryption is performed by XOR'ing the row **504** of the encrypted block with the row **502** of the encryption mask.

[0038] The bitwise XOR operation can be extended to cover entire blocks. The length of the seed stored in the ROM **26** for the first pseudorandom number generator **24** is long enough to ensure the required cryptographic strength. Once the 32K byte are of random numbers is created, the associated RS-PC redundancy data are then calculated to complete the encryption mask. Because calculating the RS-PC redundancy data is a relatively trivial matter, little processing power is needed to calculate the RS-PC redundancy data.

[0039] As a result of the foregoing operations, the error correction capability of the RS-PC codewords is preserved. Referring to **FIG. 6**, noise and defects in the storage media introduce errors that are scattered throughout the original RS-PC block **602**. The errors are indicated by dots. The encryption mask **601** does not contain errors. When the encryption mask **601** and the RS-PC block **602** are XOR-ed, the integrity of the error correction capability is maintained. Thus, the encrypted data block **603** contains errors in the same locations as the RS-PC block **602** and the RS-PC codewords are all consistent so that error correction can be successfully performed. Even if there were errors in the encryption mask **601**, errors could still be corrected and the encryption and subsequent error correction would operate satisfactorily.

[0040] The processing power required by the pseudorandom number generators **24, 42** and the RS-PC encoder **28** is not significant when compared to the processing power required to perform error code correction. The invention, therefore, imposes only a small burden on the DVD-ROM drive **16** and DVD decoder card **36**, while removing the larger burden of performing error code correction. Error code correction can be shared between the DVD-ROM drive **16** and the host processor **14** or left entirely to the host processor **14**.

[0041] The basic steps of the invention are as follows:

[0042] 1) A seed is provided. The length of the seed is long enough to ensure the required cryptographic strength.

[0043] 2) A block of random numbers is generated by a pseudorandom number generator, which is seeded or initialized by the seed.

[0044] 3) Error correction codewords are generated according to the same error correction code generation scheme as was used for the RS-PC block stored on the storage medium. In this way, a sequence of codewords is generated, all of which are determined by the random number seed and which are consistent with the original block stored on the storage medium. Resulting is an encryption mask.

[0045] 4) A bitwise XOR is performed between the original RS-PC block and the encryption mask.

[0046] 5) The block resulting from the bitwise XOR operation also includes valid codewords which contain any errors contained in the codewords read from the storage medium. No additional errors are introduced because the encryption mask does not contain any

errors. The block resulting from the bitwise XOR operation is effectively encrypted and can be sent to the host processor or other processing entity for error correction without risk of unauthorized copying of the original data.

[0047] 6) Error code correction is performed by the host processor. An error-corrected, but still encrypted block is sent downstream the host processor without risk of unauthorized copying of the original data.

[0048] 7) If decryption is performed by a trusted entity (e.g., an MPEG decoder) downstream the host processor, only the seed need be transferred to the trusted entity. The seed can be transferred in a secure manner using a key that is authenticated and exchanged in accordance with standard techniques. The trusted entity then generates a decryption mask using the same random number pattern used by the encryption mask for encryption of the user data. The decryption mask is bitwise XOR-ed with the user data of the error corrected, but still encrypted data block. Resulting is an MxN block of decrypted, error-code corrected user data.

[0049] 8) If an entity downstream the host processor does not perform decryption on the block, the seed is not transferred to that entity. Similarly, if an entity downstream the host processor is not allowed access to the data in the block, the seed is not sent to that entity.

[0050] Thus far, the invention has been described in connection with encryption of an entire RS-PC block. However, situations might arise where it is not necessary to encrypt the entire RS-PC block. Only a portion of the RS-PC block might need to be encrypted. For example, a portion of the lead-in area might contain confidential data relating to encryption. However, the initial bytes of the 172×192 block of user data (i.e., the header) contains address and other header information that are not confidential. Therefore encryption mask bytes corresponding to the header are all zeroes, and the remaining bytes are pseudo random numbers. This allows the host processor **14** to error-correct and confirm the block address, but not to have access to the confidential data, (which it sends to the DVD decoder card **36**). Thus, portions of the RS-PC block are selectively encrypted, thereby protecting the confidentiality of the data from the host processor **14** and perhaps other entities **49** downstream the host processor **14**.

[0051] In another example, an ECC block read from the storage medium already contains encrypted information in certain areas. Therefore, the data that is already encrypted is not in danger of being exposed on the computer bus and, therefore, does not have to be further encrypted by the drive. However, the ECC block also contains highly confidential, title key data in the header area. Additional header information, such as the address, is not confidential. In this case, only the confidential data in the header needs to be protected. Therefore, the encryption mask contains all zeroes everywhere except at the confidential header data byte locations (which contain pseudo random numbers). This allows the host processor to error correct the ECC block, verify the address and pass on the user data, without gaining access to the confidential information.

[0052] **FIG. 2** shows a method of selectively encrypting data in an ECC block. An ECC block is read from a storage medium (block **200**). If only a portion of the data in the ECC block (e.g., a byte sequence) needs to be kept confidential, the drive (e.g., a CD ROM or DVD drive) provides an encryption mask including random numbers corresponding to the locations containing confidential data and zeroes elsewhere (block **202**). The locations of the zeroes in the encryption mask can be determined by convention. For example, if by convention, the header information is to be protected, the encryption mask will contain random numbers at the header locations and zeroes elsewhere. The encryption mask also includes ECC redundancy data for the random numbers and zeros.

[0053] Next, the encryption mask block is bitwise XOR'ed with the ECC block (block **204**). The partially-encrypted block that results includes valid ECC codewords, encrypted data at the header location, and unencrypted data elsewhere.

[0054] The partially-encrypted block is sent to the host processor, which performs error code correction (block **206**). Additionally, the host processor accesses the unencrypted information (block **208**).

[0055] The error-corrected block is then sent to one or more additional entities (block **210**). At each entity a random data sequence may either be reused for processing subsequent data, or a new random data sequence may be generated for each quantity of data to be processed. Additional encryption, either full or partial, by each additional entity would add additional layers of protection. It would also allow selected data to be made available to selected entities. The corrected non-confidential data would be available for immediate use. Seeds would not be sent to entities not performing decryption or not having access to the confidential data.

[0056] When generating the encryption mask, filling in the zeroes is not necessary. Instead, random numbers can be provided and the redundancy bytes can be generated from the random numbers and their locations. Selective portions of the ECC block can then be bitwise XOR'ed with the random numbers and the redundancy bytes.

[0057] **FIG. 3** shows a method in which a drive performs basic ECC and the host processor performs more complex error correction. The drive reads an ECC block from a storage medium and buffers the ECC block (block **300**). The drive includes a relatively simple circuit that performs a simple error correction algorithm for identifying and correcting the majority of errors in the buffered ECC block (block **302**). In the event the error correction circuit cannot correct a data block, some or all of the buffered ECC block is encrypted (block **304**) and sent to the host processor (block **306**). The host processor then performs a more complex error correction routine to recover the errors (block **308**). Such flexibility would allow for a fast, inexpensive error correction circuit to be used in the drive, which would lower the cost of the drive and improve the speed of performing error correction. Additionally, error correction capability would be improved. This is particularly important for long-term storage of data.

[0058] Thus disclosed is an invention in which ECC-encoded data is encrypted without affecting the integrity of the ECC codewords. The invention allows encrypted data to be error code corrected in the host processor and subse-

quently decrypted. Performing error code correction in the host processor, in turn, allows for the cost of the storage device to be lowered by reducing expensive ECC circuitry and reducing static RAM.

[0059] Another advantage of performing ECC in the host processor is that the host processor, unlike hardware, has the flexibility to utilize different ECC routines. Whereas a hardware circuit is typically restricted to using the same ECC algorithm or set of algorithms for all situations, the host processor can use different algorithms. For example, the host processor could analyze the entire ECC block without modifying (i.e., correcting) any data and then decide upon the best strategy to avoid miscorrection. Miscorrection of data can be a problem, especially during on-the-fly processing. A hardware RS-PC decoder typically performs error code correction on the fly and might miscorrect data and, consequently, increase the number of errors in the data block. Miscorrection further increases the likelihood of the block being uncorrectable. A more flexible approach adapted by the host processor could avoid this problem by analyzing the data and error patterns before making any modification to the data block.

[0060] Among other advantages, encryption and decryption are performed by sending only a minimal amount of confidential information—the seed—across the computer bus. The encryption mask is not exposed on the bus. Since the drive manufacturer of a drive such as a DVD-ROM drive will typically sell the decoder card as well, the drive manufacturer can specify matching same pseudorandom number generators on the drive and the decoder card.

[0061] The host processor can perform error code correction without having access to the encrypted data. In the alternative, selective encryption can be performed, in which case the host processor has access to only selected information. Corrected non-confidential data is immediately accessible for use.

[0062] Although the invention has been described in connection with a DVD-ROM drive, it is not so limited. The invention is especially applicable where forward error correction is needed, and where it is not practical for the sender to retransmit data. Data storage devices other than DVD players include CD players, Digital Data Storage (DDS) players, and Digital Video Cassette (DVC) players. Other applications include space and mobile communication devices. Thus, the source of the ECC blocks is not limited to a ROM drive.

[0063] Specific embodiments of the invention have been described and illustrated above. However, the invention is not limited to the specific forms or arrangements of parts so described and illustrated. For example, the invention can use error correction methods other than the Reed-Solomon Product Code. This, of course, will depend upon the encryption method used for the data stored on the storage medium.

[0064] Instead of generating a seed and an encryption mask, the DVD-ROM drive could access an apriori encryption mask from a ROM. The DVD-decoder card would also access the encryption mask from a ROM. In addition to reducing processing power, this embodiment would avoid the need for the DVD-ROM drive to pass the seed to the DVD decoder card.

[0065] Therefore, the invention is not limited to the specific embodiments described and illustrated above. Instead, the invention is construed according to the claims that follow.

What is claimed is:

1. A system comprising:

a computer bus;

a host processor connected to the computer bus, the host processor being programmed to perform error code correction;

a drive including means for providing a block of ECC-encoded data; means for providing an encryption mask; means for performing a bitwise XOR of the encryption mask and the block of ECC-encoded data, a product of the bitwise XOR being an encrypted block, an output of the bitwise XOR means being coupled to the computer bus, whereby the encrypted block can be sent to the host processor via the computer bus for error code correction.

2. The system of claim 1, wherein the means for providing the encryption mask includes means for providing a seed, a pseudorandom data generator for generating a sequence of random numbers from the seed, and an ECC encoder for generating an encryption mask including first and second portions, the first portion including the random numbers, the second portion including redundancy data for the first portion.

3. The system of claim 2, further comprising means, coupled to the computer bus, for receiving the encrypted block from the host processor; means for receiving the seed from the drive; a second pseudorandom generator for generating a decryption mask from the seed; means for performing a second bitwise XOR of the decryption mask and user data in the encrypted block, a product of the second bitwise XOR providing unencrypted user data.

4. The system of claim 3, further comprising an MPEG decoder coupled to an output of the means for performing the second bitwise XOR.

5. The system of claim 4, wherein the drive is a DVD-ROM drive, and wherein a DVD decoder card includes the MPEG decoder, the means for receiving the encrypted block, the means for receiving the seed; the second pseudorandom generator and the means for performing the second bitwise XOR.

6. The system of claim 1, wherein the ECC block includes a first portion for user data and a second portion for redundancy data, and wherein the encryption mask includes third and fourth portions corresponding to the first and second portions, respectively, of the ECC block.

7. The system of claim 6, wherein the third portion is filled with a plurality of numbers, and wherein the fourth portion includes redundancy data generated from the third portion.

8. The system of claim 6, wherein the third portion is filled selectively with a plurality of numbers, and wherein the fourth portion includes redundancy data generated from the third portion.

9. The system of claim 1, wherein the ECC block is coded according to an error code correction method, and wherein the encryption mask is coded according to the same error code correction method.

10. The system of claim 1, wherein the drive further includes means for performing error code correction, and wherein the host processor also performs error code correction on the encrypted data sent by the drive.

11. A drive comprising:

means for reading an ECC block from a storage medium;

means for providing a seed;

a pseudorandom data generator for generating a sequence of random numbers from the seed;

means for generating an encryption mask including a sequence of random numbers and redundancy data, the random numbers being generated from the seed; and

means for performing a bitwise XOR of the encryption mask and the ECC block, a product of the bitwise XOR being an encrypted ECC block.

12. The drive of claim 11, wherein the ECC block includes a first portion for user data and a second portion for redundancy data, and wherein the encryption mask includes a third and fourth portions corresponding to the first and second portions, respectively, of the ECC block.

13. The drive of claim 12, wherein the third portion is filled entirely with random numbers, and wherein the fourth portion includes redundancy data generated from the third portion.

14. The drive of claim 12, wherein the third portion is filled selectively with random numbers and zeros, and wherein the fourth portion includes redundancy data generated from the third portion.

15. The drive of claim 11, wherein the ECC block is coded according to an error code correction method, and wherein the encryption mask is coded according to the same error code correction method.

16. The drive of claim 11, further comprising means for performing error code correction on the ECC block.

17. A method of transmitting secured data over a bus, the method comprising:

receiving an ECC block;

generating an encryption mask including a plurality of numbers and redundancy data;

performing a bitwise XOR of the encryption mask and the ECC block, a product of the bitwise XOR being an encrypted ECC block; and

sending the encrypted ECC block over the bus.

18. The method of claim 17, further comprising the step of using the host processor to perform error code correction on the encrypted block.

19. The method of claim 17, further comprising the step of performing partial error-correction on the ECC block before performing the bitwise XOR and sending the encrypted block sent over the bus.

20. The method of claim 17, wherein the ECC block includes a first portion for user data and a second portion for redundancy data, and wherein the step of generating the encryption mask includes the steps of filling a first portion of the encryption mask entirely with random numbers, and filling a second portion of the encryption mask with redundancy data for the first portion, the first and second portions of the encryption mask corresponding to the first and second portions of the ECC block.

21. The method of claim 17, wherein the ECC block includes a first portion for user data and a second portion for redundancy data, and wherein the step of generating the encryption mask includes the steps of filling a first portion of the encryption mask selectively with numbers and zeros, and filling a second portion of the encryption mask with redundancy data generated from the numbers, the first and second portions of the encryption mask corresponding to the first and second portions of the ECC block.

22. The method of claim 17, further comprising the step of decrypting the encrypted block, the step of decrypting including generating a decryption mask; and performing a bitwise XOR of the decryption mask and user data in the encrypted ECC block, a product of the bitwise XOR providing unencrypted user data.

23. The method of claim 22, wherein the encryption mask is generated during encryption via a seed and a random number generator algorithm, and wherein the decryption mask is generated during decryption by using the same seed and the same random number generator algorithm.

24. The method of claim 17, further comprising the step of regenerating the encrypted block for subsequent data transmission.

25. The method of claim 17, further comprising the step of reusing the random data block for encryption of subsequent data blocks.

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